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ELECTRICAL GLASS MELTING

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PART I

Attempts to melt glass electrically go back to the year 1880. Success was first achieved in the previous two decades of this century, after several efforts finally brought about a sound technical procedure.

Today, a large number of glass factories have gone over to electrical melting, and many of the installations have operated for years, with good results. The Swiss industries have taken the lead in developing electric furnaces for glass and in their introduction in practical glasshouse operation. The solution of the problems involved is of particular importance for countries having abundance of water power but lacking coal—the situation in Switzerland.

The outlay for fuel is decisive in the efficiency of most melting operations. It amounts to some 20 to 30 per cent of operating costs in the glass industry. For example, the relative operating costs in the manufacture of bottles are as follows:

	%
Fuel	26
Raw Materials	19
Wages	22
Other Materials	4
Auxiliary Services	9
Expense and Depreciation	20
	100

The outlay for fuel is distributed:

	%
Melting	60
Annealing	11
Power	17
Auxiliary Firing	6
Space Heating	6

These relationships make it necessary that the most important centers of the glass industry be near the mines of coal and lignite. In countries with cheap fuel oil, such as America, England, and Holland, oil-firing has in late years become important.

The electrical glass furnace is competitive, only if the higher working temperature, other economies, or special conditions compared with fuel-firing make it possible to off-set the higher cost of electrical energy.

Pot and Tank Furnaces

Glass technology distinguishes two fundamentally different melting processes: pot and tank melting. In pots, the melting process is periodic. The glass is melted in large crucibles, the pots (6 to 16 in a furnace), and from them the finished glass is gathered for working. In contrast, the glass is melted continuously in the tank, batch being added at one end while finished glass is worked out at the other; the glass flows lengthwise of the furnace. In general, the tank exceeds in efficiency the pot furnace.

Gas Evolution in Glass Melting

During glass melting, gases are evolved which are driven out by raising the temperature during the fining period. Their volumes are many times the volume of the glass itself. Gases originate from the reactions accompanying the formation of glass. They consist for the most part of CO and CO_2, with SO_3 when sulfate is present, and steam if the batch contains moisture. With indirect resistance heating, the escaping gases may, under some conditions, affect the hot resistance.

The Viscosity of Glass

Viscosity is by far the most important property of glass. Only with certain knowledge of the laws governing viscosity has it been possible for glass technology to develop so far, particularly in modern mechanical production.

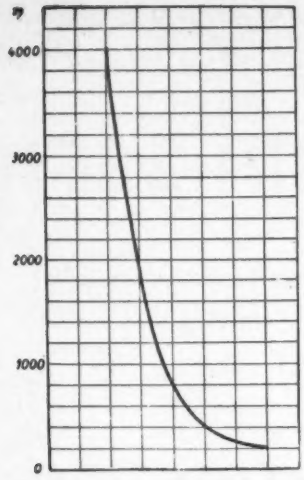

Fig. 1. The Viscosity of Glass in Relation to Temperature.

Upon viscosity depend not only the behavior of glass during the melting process, but also its behavior in annealing, forming, and further re-working.

Metals pass from the fluid to the solid, crystallized state at a definite temperature, characteristic of each metal, the melting or freezing point. This is not so with glass. The internal structure of glass is conditioned by the rapid increase of viscosity as it cools from the fluid state of aggregation. (See Fig. 1)

When fluid glass is cooled, the viscosity increases above the *aggregation temperature* only slowly, then mounts rapidly. Above the aggregation temperature, which may be regarded somewhat as corresponding to the melting point of a compound, the glass is in the fluid condition. Below the aggregation temperature, the glass is in a pasty condition, designated as the viscous state. Upon further cooling, the glass becomes stiffer and stiffer and goes imperceptibly—that is, apparently at no definite temperature point—into the brittle or solid condition of complete freezing. It behaves like an undercooled liquid.

Glass is an amorphous material for the molecules must move freely if crystal nuclei are to form and grow to crystals. This is the case in the crystallization of metals; but in glass, on the contrary, crystallization does not begin when the aggregation temperature is reached and passed. Viscosity increases so rapidly that, through hindering the free movement of the molecules, crystallization is hindered.

H. Le Chatelier[1] has stated the so-called doubled logarithm law for the dependence of viscosity of glass upon temperature. It reads:

$$\log \cdot \log \eta = M \left(\frac{\theta - 1000}{1000} \right) + N$$

In which:

M = Coefficient of increase of viscosity;
η = Viscosity of the glass;
θ = Temperature in °C.;
N = Viscosity of the glass at 1000°C.

It is apparent from this law that the increase of viscosity is so swift that taking the logarithm twice is necessary in order to produce a linear graph.

Fining and Flow of Glass in Tank Melting

Until recently, it was assumed that the glass in the tank flowed only in the direction of the lengthwise axis from charging end to working openings, and that the glass, on its way through the melt, could never pass through a higher temperature than a previous maximum.[2] However, recent and more certain studies with the most modern instruments demonstrate the fact that the currents of the glass in the tank are controlled much more by thermal gradients than by the simple flow caused by drawing out the glass. Cross-currents arise. The glass flows in reverse toward regions having lower temperatures. Since it cannot pile up there, it sinks because of increased specific gravity resulting from cooling, especially down the cooler walls of the tank, then returns along the bottom to rise again at the point of highest temperature, which has been designated the "spring" or "fountain." The actual relationships of the currents in the tank can best be portrayed by the schematic Fig. 2.

According to the earlier views, the phenomena attending the fining of glass in pots corresponded with what occurs in tanks. In pots, the old dictum suffices that, during the fining period, the glass had the highest temperature. Thus, Zschimmer speaks of a "temperature jolt." New researches now show that the glass in the tank also actually goes through a similar temperature treatment during fining, as that exhibited in Fig. 2, for the "spring" region is also the zone with the highest temperature.

Conductivity of Glass at Elevated Temperatures

The possibility of using the glass bath itself as the heating resistance arises from the fact that, in a temperature range above 100 to 200°C., depending upon the variety, glass becomes electrically conducting. The conductivity[3, 6] is dependent upon the composition of the glass, but a simple formula for the relationship has not been devised. The conduction is electrolytic, and thus is related to Faraday's Law. For this reason, only alternating current can be used when glass is the resistor for heating.

Rasch and Hinrichsen gave the following formula for the dependence of the conductivity of glass upon the absolute temperature:

$$\log \rho = \log \frac{1}{G} = \frac{\nu}{T} + C_1$$

in which:

ρ = Specific Resistance of the Glass;
G = Conductivity;
T = Absolute Temperature in °K;

and ν and C_1 are constants depending on the nature of the glass, which suddenly take on other values at the beginning of softening, at a temperature characteristic for each glass.

Recent work on the specific electrical resistance of different glasses in the temperature range of the electrical melting furnace between 1200° and 1600°C. has been published, providing data for the curves of Figs. 3 and 4.

The compositions of these glasses is given in Table I. The conductivity can be derived from the curves after the known formula:

$$G = \frac{1}{\rho}$$

No simple, additive method is yet known for calculating

TABLE I

COMPOSITION AND SPECIFIC ELECTRICAL RESISTANCE OF GLASSES

(Values for Spec. Res. (ρ) are taken from Figs. 3 and 4)

Glass	Curve, $\rho = f(T)$ *Fig.*	*No.*	Composition, per cent SiO_2	Na_2O	K_2O	CaO	MgO	Al_2O_3	B_2O_3
Soda Silicate ..	3	1	76.0	24.0	—	—	—	—	—
Potass. Silicate.	3	2	71.0	—	29.0	—	—	—	—
Common ...	4	C	70.0	14.7	—	12.5	0.5	1.3	—
Soda-Lime ...	4	B	72.0	15.5	2.7	5.2	3.7	0.8	—
Sil. Glasses ...	3	3	71.6	15.0	—	10.7	2.0	0.5	—
Lamp Glass ...	4	A	67.0	11.0	9.5	6.0	—	—	2.0
	3	5	67.5	6.8	3.6	6.8	0.1	6.5	7.9
Neutral Glass ..	4	D	64.0	7.5	—	5.0	—	10.0	8.0
	4	F	79.0	4.3	—	—	—	2.0	14.0
Pyrex	3	6	80.5	3.9	1.0	0.4	—	2.0	11.9
Res. Glasses ...	4	G	81.0	3.9		—	—	2.0	12.0
Borosilicate ...	4	E	61.0	9.0	—	—	—	3.5	25.5
Lead	3	4	56.5	5.4	8.6	PbO, 29.5		0.1	—

with much certainty the specific resistance of a glass from its composition. Moreover, the measurement of resistances at high glass temperatures is difficult and tedious. Borel[7] suggests a calculation on the basis of alkali content, in which an established resistance curve for a glass with closely similar composition furnishes a starting point. He starts with the assumption that the conductivity is proportional to $(Na_2O + K_2O/2)$ for two comparable glasses. The fact that this method, used with great caution, will give only approximate values can be seen from a casual comparison of the curves in Figs. 3 and 4. Notwithstanding the close similarity of composition in glasses No. 6 and G, and notwithstanding only unessential difference in alkali content, these two glasses have quite different electrical conductivities. Borel makes also the limitation, however, that the approximate method yields useful results only when the content, $(Na_2O + 0.5K_2O)$, lies between 10 and 20 per cent and also the Al_2O_3 content is under one per cent.

The conductivity of glasses is, then, electrolytic in character, and dependent upon the mobility of the cations of the alkali metals along with their concentration, size, and potential[8]. On the other hand, the influence of internal friction, that is, the resistance offered by viscosity in opposing the movement of cations, must not be neglected. Alkali content alone, therefore, must not receive all attention because the influence of other components of the glass cannot remain outside the picture. A comparison of curves B and C in Fig. 4 and curve 3 in Fig. 3 shows in this connection notably greater deviations for ρ than would correspond to changes in alkali content (Curve 3: $Na_2O = 15\%$; Curve C: $Na_2O = 14.7\%$; Curve B: $Na_2O + 0.5K_2O = 17.85\%$). The method of calculating described above appears to be, then, only useful as an approximation for common soda-lime-silica glasses. It appears advisable to determine the curve $\rho = f(T)$ by measurement for each individual case.

The Electrical Resistance of Refractories

At the temperatures prevailing in glass melting furnaces, even the refractory materials of which the furnace walls are built begin to show measurable electrical con-

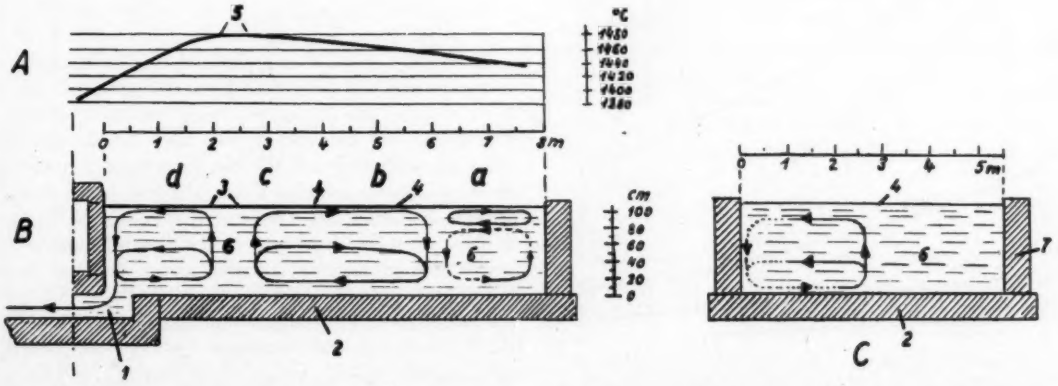

Fig. 2. True Course of Currents in a Tank with Throat, Shown in Vertical-Longitudinal Section Through "Spring." A, Temperature of the glass at the upper surface taken along the long axis of the tank; B, Flow of the glass in vertical section longitudinally through the middle of the tank; C, Currents in vertical section in the region of the "Spring": (1) The deep flow of the glass through the throat, (2) Bottom of the tank, (3) The region of the "Spring," (4) Surface of the glass bath, (5) Maximum temperature of the glass at the "Spring," (6) Glass bath, (7) Sidewalls of the tank; a, b, c, d, Burners of the fuel-heated tank with cross-firing.

ductivity. In the selection of a suitable quality of blocks, high specific electrical resistance in the temperature region 1000°-1600°C. is a property not to be neglected.

The Apparent Resistance of the Circuit in an Electric Glass Tank

To measure the actual resistance of the glass in an operating tank, electrically heated, is a difficult problem. The current that flows between two electrodes immersed in hot glass does not lend itself to simple calculation according to Ohm's Law because the different layers of the glass participate differently in carrying the current. We must speak, therefore, of the apparent resistance Rs of the glass bath between electrodes.

Peyches[9] has tried to bring out a formula for the apparent resistance for several practical styles of electrodes and for different arrangements of them. He began with the assumption that a distribution of the current exists, analogous to the electrostatic field, that would establish itself between electrodes of the same form and arrangement in a *homogeneous* medium. It is to be remarked, however, that the assumptions underlying the application of this formula are in few instances fully justified. For example, the glass bath in the melting tank is bounded below by the bottom and above by the mirror-surface, whereas the formula does not take this circumstance into the reckoning. The depth of the current is influenced also by every change in the cross-section of the tank. The conditions at the walls must accordingly be carefully observed. Peyches becomes emphatically attentive to these conditions and recommends experiments with models with employment of a standard electrolyte for the experimental determination of correction factors.

The glass in the tank is far from being a homogeneous liquid. It is apparent from Figs. 3 and 4 that a comparatively small temperature difference can cause a great change in the specific electrical resistance of glass. Large variations in temperature are inevitable in the normal course of the melting process. The glass in the refining

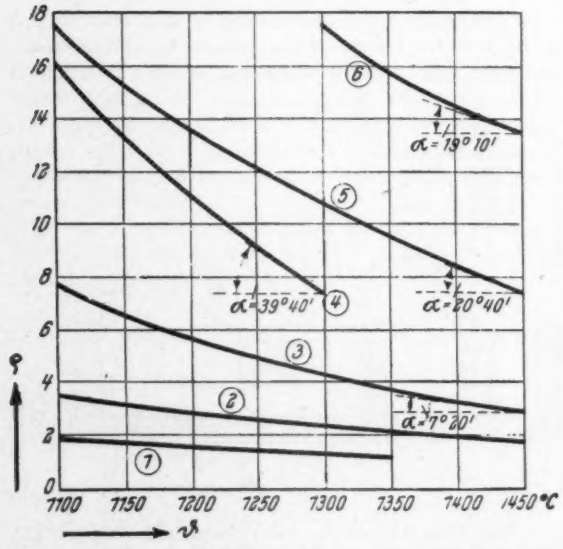

Fig. 3. Specific Electric Resistance of Glass of Different Composition, in the Temperature Range of the Electric Glass Melting Furnace. (After Borel; Glass Compositions Shown in Table 1 Designated by Numbers.)

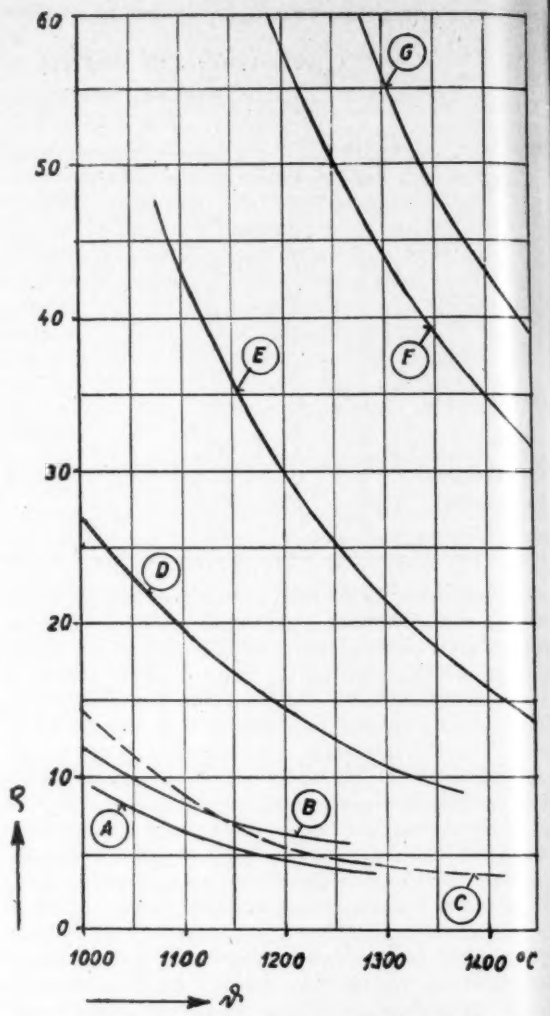

Fig. 4. Specific Electric Resistance of Glass of Different Composition (After Peyches; Compositions Shown in Table 1 Designated by Letters.)

zone is some 150 to 250°C. hotter than at the charging end, and further undergoes a drop of 250 to 450°C. to reach working temperature. Also, the glass near the sidewalls is perhaps 50°, and at the bottom of a tank of normal depth (0.9-1.0 m.) perhaps 100-150°, cooler than in the middle of the tank. Great differences in conductivity result, with the cooler zones setting up higher resistance to the electric current and thereby becoming relatively still cooler, while the hotter zones, with lower resistance, carry a larger share of the current, and some danger of overheating these zones may result. These difficulties must be overcome in the furnace operation by means of regulating each pair of electrodes, that is, each circuit, by controlling the impressed voltage.

Finally, let it be remembered that the curves for electrical resistance were obtained from measurements on ready-melted glasses, whose glass forming process were complete and whose composition in mass was accordingly homogeneous. In the glass melting tank, at least in the melting and fining zones, quite other conditions prevail. Numerous intermediate products form in the fluxing mass out of which, on the way through the tank,

the finished glass slowly forms by chemical change and admixture. These intermediate products naturally have different, generally higher, electrical resistances than that measured for the finished glass.

Discoloration of the Glass by the Electrodes

In the construction of electric glass melting furnaces with direct-resistance heating, great difficulties are encountered because of the discoloration of the glass by the electrodes. This defect arises from the attack of the glass on the electrodes forming oxides with coloring power. These color phenomena vary according to the kind and composition of the base glass. In general, the following

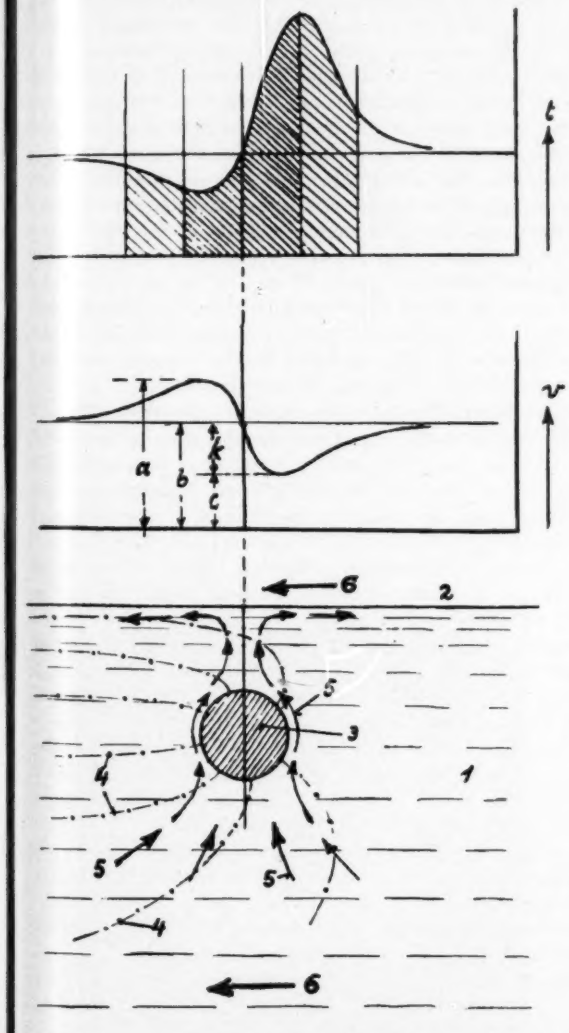

Fig. 5. Course of convection currents forming in an electric melting tank near a round electrode lying horizontally, and their influence on the speed of the stream of glass: (1) The glass bath; (2) Upper surface; (3) Electrode; (4) Course of Currents between electrode shown and another one at the left, near the surface; (5) Course of convection currents; (V) Speed of surface convection currents (÷, in the direction of the general flow of glass; that is, below the electrode; —, above the electrode; (6) Direction of the main glass stream; (C) Minimum glass speed existing = V min. = b — k, Maximum glass speed = V max. = b + k; (t) $\frac{.1}{V}$; (b) Mean glass speed.

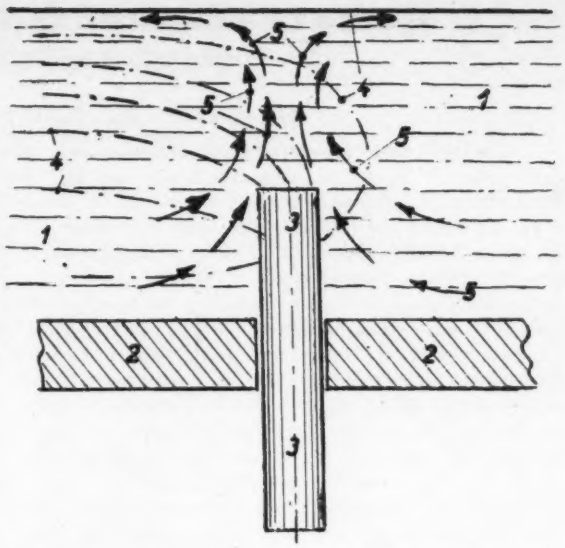

Fig. 6. Convection Currents in the Tank with Electrodes Projecting Upward Through the Bottom: (1) The glass bath, (2) Tank bottom, (3) Vertical electrode, (4) Path of currents between the electrode and another one at its left, (5) Currents rising from the vertical electrode.

colorings may be expected:

Violet: Manganese and nickel oxides;
Blue: Cobalt and copper oxides;
Green: Iron, copper, chromium, and uranium oxides;
Yellow: Iron (ferric), antimony, cerium, and uranium oxides, sulfur, carbon (graphite) electrode-dust in arc furnaces;
Red: Copper, gold, selenium.

Extremely small amounts of oxides are often enough to color the glass strongly. For example, more than 0.1 per cent Fe_2O_3 cannot be compensated by selenium.[11] Metallic iron, resting in contact with the molten glass, slowly dissolves with gas evolution[12] and forms iron oxide, usually FeO. The solution does not form homogeneously. It produces streaks, which by the movement of the glass, are drawn into colored cords.[13]

This attack on electrodes immersed in the glass is accelerated by the electrolytic behavior of the glass at high temperatures. Upon the passage of the current, the sodium contained in the glass in part wanders and is replaced by the metal of the electrode. According to Bryson,[14] the whole process takes place in colloidal form, and practically all electrode materials except platinum are attacked.

Iron of the utmost purity, with a carbon content below 0.03 per cent, is likewise almost free from attack,[15] whence its use in the Cornelius tank furnace. Researches on the behavior of such electrodes (in a Cornelius experimental furnace) have, however, shown results of great inconsistency. The following were studied: Electrodes of ordinary iron, of a stainless steel with 15% Cr and 0.6% Ni, of soft iron with 0.5% and 0.025% C, and of a magnetic steel with 3.8% Cr. With this magnetic steel, the loss in weight caused by attack of the liquid glass on the electrode reached only 0.15% in a day. Electrodes of common soft iron lost 0.5% in a day, but if the iron were electroplated with chromium, the loss was reduced

(*Continued on page 98*)

QUALITY CONTROL IN THE MANUFACTURING OF GLASS CONTAINERS

By JULIAN H. TOULOUSE, Chief Engineer

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Applications of statistical quality control in the glass container industry are few in number and very much influenced by certain aspects of the industry which make it truly different from other industries.

In most industries the final product is the result of an assembly operation. Inspection of the piece parts can be made at several stages, and almost always the process can be interrupted at any of these stages to allow further inspection and detailing. Usually, sufficient storage of piece parts is possible so that operations in sequence on the same part, or assembly operations, can be delayed or scheduled without regard to the final product.

In the forming of glass containers, we are dealing with a "one-process" production. The molten glass feeds into a bottle-forming machine, where the finished article is pressed or blown in a single operation of perhaps eight to ten seconds duration. Nothing further is ever done, or can be done, to the bottle in any way that would influence dimension or other quality except that the bottle is automatically transferred from the forming machine to the annealing oven, from which it emerges as a finished bottle ready to ship to the user.

At the packing stage, after being annealed, the bottle is given a 100% inspection. Nothing yet has been found to substitute for this inspection because visual characteristics of glass have no bottle-to-bottle or production relationship, and are usually truly random in character. It is necessary for screening operation, and cannot be handled by sampling.

For this reason, quality control in the industry has grown up around the final inspection operation. Even the measurement details, which are handled as a sampling operation, are on the final product, and because of the annealing process, delayed for a period of 1½ to 2 hours behind production.

Therefore, the quality control uses in the industry can be summarized as: (1) Raw material inspection; (2) 100% visual examination (selection); (3) Re-inspection or statistical examination of results of selection (inspection); (4) Statistical quality audits; (5) Measurement sampling inspection; (6) Strength sampling inspection; (7) Customer acceptance sampling; (8) Research in product and production.

Raw Material Inspection. Some glass manufacturers have specification controls for incoming raw materials; others have not. Most of those specifications are upon chemical purity; some involve a grain-size analysis. None of a statistical nature has been reported.

100% Visual Selection. These are obviously not statistical in nature. Records from the hour-to-hour results are usually kept but, because of the lag in time, are not usually analyzed statistically for production. Important facts are relayed to the forming line as deemed necessary by the supervisors or crew-leaders of the selection crews. From 10 to 30% of the direct production personnel of the plant may be selectors.

Presented before the Metropolitan Section of the American Society for Quality Control, Rutgers University, New Brunswick, N. J.

Re-inspection. A possible application of statistical methods, but on which no information has been reported, is in the examination of the work of the selectors by spot sampling of their results. Many glass companies do this on a percentage basis, re-examining a per cent of each selector's work, both being matters of visual appearance characteristics only.

Measurements. Until much more is known of the natural variation of the product to allow statistical applications, measurement details will probably continue on a go-no-go basis. The sample is prescribed by A.S.T.M. Test Method C-224 and is based on one-bottle-per-cavity (a cavity being one of the 4 to 45 bottle-forming units which may be operating on the same forming machine at the same time). From the practical standpoint, so little real difficulty is being encountered that there has not yet been justification for taking a three or four bottle per cavity sample at each testing interval in order to apply control chart techniques.

Strength Tests. The same applies to strength tests which are designated by A.S.T.M. test methods C-147, C-148, and C-149. In addition, the strength tests and machines for conducting the tests are designed on a go-no-go basis. The first measurement type of strength test has just been developed and is now under commercial trial, which might permit of a statistical treatment later. In general, however, the strengths are so much in excess of the minimum limits that no difficulty is encountered with the present methods.

Customer Acceptance Sampling. Since this is to be covered by another speaker, it will be mentioned only as a part of the general picture. Specifications written on a statistical basis are being discussed, both by glass companies as individuals and by the glass container industry, both with individual customers and customer industries. It has stimulated a greater interest and understanding of the subject. One result has been the employment of similar examinations by the glass container manufacturers, both using the customer's plan and the methods of A.S.T.M. designation C-224 on sampling.

Research. Many glass container manufacturers are using statistical methods in research, of which those covering specifications are most interesting. Much of other applications rests on better knowledge of manufacturing variability and, in particular, a possible completely new approach to the writing of specifications.

OPS ALLOWS PRICE INCREASE FOR GLASSWARE

To meet minimum earnings standards of the industry, the OPS has permitted an immediate 7% increase in manufacturers' ceiling prices for machine-made household and commercial glassware, such as table, cooking, and decorative ware and smokers' accessories.

Retail ceilings may be increased in line with customary mark-ups. The manufacturers' increase may be applied to his highest selling price since July 1, 1952.

THE SURFACE OF A GLASS FRACTURE IN THE ELECTRON MICROSCOPE

By NOBUZO TÉRAO and SHIGÉFUMI OKADA*

TRANSLATED BY DR. F. W. PRESTON

Abstract

The surface of the origin of a glass fracture, the so-called mirror area, has been examined with an electron microscope. More particularly, we have observed small round bodies in the polished area around the origin. We conclude that these small bodies are possibly fractures of a lenticular shape which are produced parallel to the principal fracture surface when glass ruptures suddenly.

When a brittle body, such as glass or pitch, is broken violently, there is found at the origin of the fracture a small, substantially flat surface with a quite distinctive appearance, known as the origin or mirror area.[1-5] This small surface throws important light upon the origin of the fracture, and Mr. M. Hirata has shown that there is an intimate relationship between strength at failure and the mirror area.[6] With a hope of better understanding the mechanism of the sudden failure of glass, we have observed this origin of the fracture with an electron microscope.† In the first instance, we broke a rod of glass with a diameter of 7 mm. in static bending in order to obtain a fracture showing a suitable mirror area. Promptly thereafter we made a replica in aluminum some 300 to 500 Angstrom units thick, employing the methylmethacrylate-aluminum method[7] and shadowed this with chromium. The observations upon this replica were made with an electron microscope of Hitachi HU Type 4 using an accelerating potential of 50,000 volts. The photographs in Figures 0 to 12 show one of the results obtained. Figure 0 was taken with an optical microscope and shows the mirror area, while Figures 1 to 12 are electron micrographs showing the various points marked with figures corresponding to those in Figure 0. We have also arranged these twelve figures so that they are oriented as in Figure 0. The circular surface of the mirror area, which is produced by starting at the center of the circle, is very smooth at first, but as we approach the circumference of the area, it becomes gradually uneven. (The surface of the mirror area is not composed of a single plane, but rather of two planes which meet at a slight angle. What appear like two black feathers in Figure 0 show the sloping surface at the place where these two planes cross.[8]) Near the periphery, the photographs show the fracture in the form of a striation much as it appears in the optical microscope. But in the present instance, the most noteworthy feature is the presence of the little round bodies that may be seen, for instance, in Figures 3, 4, 7, 10, and some others.

The principal observations that we have been able to make on this point are as follows:

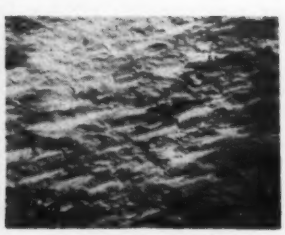
(1) These little round objects are confined exclusively to the smooth part of the mirror area.

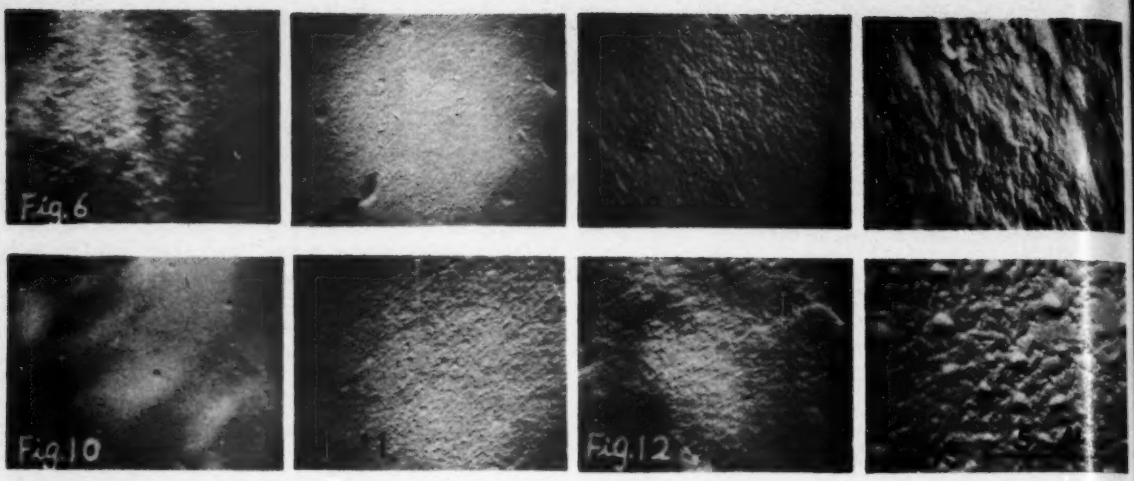
(2) They begin at a point some little distance from the origin proper, and they tend to become larger towards the periphery of the mirror area. In fact, towards the periphery, their diameter sometimes reaches more than 1 micron.

(3) It is possible to tell by the direction of the chrome shadowing whether the object is concave or convex with respect to the surrounding plane. As a matter of fact,

*The authors are at the University of Tokyo, in the Institute of Industrial Science and on the Medical Faculty, respectively, and the paper, which was presented before the Electron-Microscope Society, appears in the *Journal of the Physical Society of Japan*, Vol. 7, No. 4, July-August, 1952, in the French language. Since this journal is likely to be inaccessible to many American readers and the French language may act as a further barrier, we give herewith a translation. F. W. P.

†Translator's note: Several other people have done the same thing, but so far as I know have not reported the same phenomena.





both varieties, concave and convex, occur together on the surface of the broken glass; but so far as those photographs which we have obtained to date indicate, the convex form is much less frequent than the other. This characteristic is almost equally evident on the two complementary surfaces of a single origin.

(4) This small object is not perfectly spherical, but is somewhat flattened and has a rather glossy surface.

It seems to follow that perhaps this little round object may be a fracture shaped like a lens which is produced parallel with the plane of the mirror area while the crack is developing. It appears to us, as Mr. M. Hirata has commented, that this small fracture is of the same kind as that other lens-shaped one which is produced in quantity in the interior of the mass when amber or phenolic, whose annealing is imperfect, is hardened. It may be explained by the fact that at the moment when glass reaches a particular stress-level as a result of the application of external force, a lot of tiny, lens-shaped fissures begin to form. Then the principal surface of the mirror area is propagated through the zone in which the pre-existing fractures are arranged. Figure 13, which was obtained from a fracture of window glass lights, shows round objects. We suppose that if the concave surface appears more often than the convex, this might be due to the fact that the little lenticular element is torn away from the glass and becomes attached to the replica. It is conceivable that the tiny fracture in the flat fractured surface of the glass is produced in the making of the replica; but it is more likely that the little round object is a true feature of the fracture-surface, since none of them are ever found if a replica is made, by the same technique, of a surface of polished glass or other substance. On the other hand, there is still a possibility that it may be a phenomenon produced as a secondary effect on account of a specific reaction between the replica and the fracture-surface, since it is possible that the substantially smooth surface of the fracture may have a very different chemical nature from ordinary surfaces. This point will be investigated later with another method of making replicas.

This work was done at the Electron-microscope Laboratory of the University of Tokyo. We wish to express our warm thanks to Mr. M. Hirata, Professor of Science, for the interest he has shown in this work and for his unfailing encouragement of us. Our thanks also to Mr. H. Eto, Assistant Director of the School of Medicine, for his kindly help.

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LOWELL ROESNER ELECTED OVERMYER PRESIDENT

At a special meeting of the directors of the Overmyer Mould Company, Inc., there was a reorganization necessitated by the sudden death of C. P. Overmyer, Sr. Elected to the presidency of Overmyer Mould Company, Inc., Overmyer Mould Company of Pennsylvania, and Overmyer Mould Company of California was Lowell Roesner.

Others elected as officers include Earl Flatter, Vice President; Vernon Ruble, Second Vice President; Wilbur Snyder, Third Vice President; Charles Manrose, Secretary-Treasurer; and Robert Wallace, Assistant Secretary-Treasurer.

Directors and officers elected to Overmyer Mould Company of Pennsylvania, including Mr. Roesner as President, were James Kindelan, Vice President; Earl Flatter and C. M. Hawkins, Directors; Charles Manrose, Secretary-Treasurer; and Robert Wallace, Assistant Secretary-Treasurer.

The directors and officers elected to Overmyer Mould Company of California, in addition to Mr. Roesner, include Day Stalker, Vice President; Earl Flatter and C. M. Hawkins, Directors; Charles Manrose, Secretary-Treasurer; and Robert Wallace, Assistant Secretary-Treasurer.

• Floyd L. Greene, Chairman of the Board of General Refractories Company, was elected to the Board of Directors of The First National Bank of Philadelphia at its recent annual meeting.

THE STEADY FLOW OF HEAT THROUGH HOT GLASS

By B. S. KELLETT

Research Laboratory, Pilkington Brothers Ltd., St. Helens, Lancashire, England

If a sheet of semi-transparent material is placed between two blackbody radiators, the absorption and reradiation of radiant energy within the sheet plays some part in determining the rate of heat flow. At ordinary temperatures the radiant energy is of such long wavelength that almost any material can be regarded as perfectly opaque to it, and the radiant energy flow through the sheet is extremely small compared with thermal conduction. However, with a material such as glass at temperatures of 1000°C. or higher, this is no longer the case, and it is essential to take into account the transfer of energy through the sheet by a process of absorption and reradiation.

This paper contains a theoretical calculation of the steady flow of heat and the temperature distribution through such a screen.

The problem that will be solved is that of calculating the steady-state heat flow and temperature distribution through an infinite plane sheet of glass or similar material separating two blackbody zones at different temperatures. Two types of boundary condition will be considered. In the first, the heat transfer between the blackbody zones and the surfaces of the sheet is by radiation only; in the second case, the surfaces of the sheet are taken to be in contact with the blackbody zones so that the surfaces are maintained at the temperatures of the blackbody zones.

The following symbols are used:

θ—Absolute temperature.

x—Distance through the sheet measured from an origin in one face.

d—Thickness of the sheet.

θ_1, θ_2—Temperatures of the blackbody zones θ_1 at the side $x=0$ and θ_2 at the side $x=d$.

a—The absorption coefficient of the material (defined so that e^{-ax} is the fraction transmitted through a thickness x), assumed to be constant over the range of wavelengths concerned—that is, the material is assumed to be gray.

ρ—The reflection coefficient as the surfaces, also assumed to be independent of wavelength.

k—The thermal conductivity of the material of the sheet.

σ—Stefan-Boltzmann radiation constant.

H—Rate of flow of heat through unit area of the sheet in the steady state.

Since the sheet is taken to be infinite, the problem is one-dimensional. Consider the element of glass shown in Fig. 1, of unit cross-section and thickness dx, and denote the rate at which radiant energy reaches this element from the left by R and from the right by S. In unit time the element will absorb a fraction adx of R and the same fraction of S. By an extension of Kirchhoff's law to semitransparent bodies[2], it will also emit $adx\sigma\theta^4$ from each face. Finally, there will be a flow as a result of conduction of $-kd\theta/dx$ into the left-hand face

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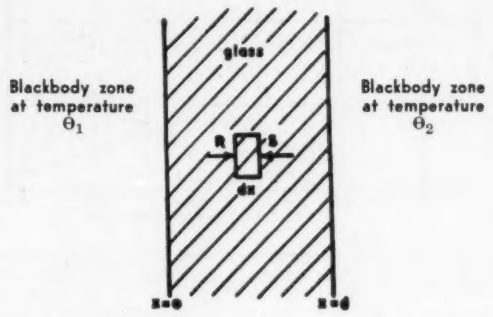

Fig. 1. Radiant energy arriving per second on an element of glass of unit cross-section and thickness dx.

of the element and $-k(d\theta/dx+dx\cdot d^2\theta/dx^2)$ out of the right-hand face. In the steady state the heat balance for this element therefore requires that

$$adx(R+S)-2adx\sigma\theta^4+kdx\cdot d^2\theta/dx^2=0,$$

i.e.,

$$kd^2\theta/dx^2-2a\sigma\theta^4+a(R+S)=0. \quad (1)$$

Further, in crossing the element of thickness dx, R suffers a loss $adxR$ but is reinforced by the $adx\sigma\theta^4$ emitted from the right-hand face of the element, i.e.,

$$dR=-adxR+adx\sigma\theta^4 \quad \therefore \quad dR/dx=a(\sigma\theta^4-R).$$

Similarly,

$$dS/dx=a(S-\sigma\theta^4),$$

so that

$$kd^2\theta/dx^2=a(2\sigma\theta^4-R-S)=dR/dx-dS/dx.$$

Integration gives $R-S-kd\theta/dx=$ a constant, which is clearly H, the rate of flow of heat.

Also

$$dR/dx+dS/dx=a(S-R)=-akd\theta/dx-aH.$$

Integration gives $R+S=-ak\theta-aHx+A$, where A is a constant. By addition and substraction it follows that

$$R=\tfrac{1}{2}(kd\theta/dx+H-ak\theta-aHx+A) \quad (2)$$

and

$$S=\tfrac{1}{2}(-kd\theta/dx-H-ak\theta-aHx+A). \quad (3)$$

Also substitution for $R+S$ in (1) gives

$$kd^2\theta/dx^2-2a\sigma\theta^4-a^2k\theta-a^2Hx+aA=0. \quad (4)$$

The solution of this differential equation would give θ as a function of x and the problem would be solved. The equation is not soluble explicitly as it stands, however.

A first approximation to the solution can be obtained by writing

$$\theta^4=\bar{\theta}^4[1+(\theta-\bar{\theta})/\bar{\theta}]^4=4\theta\bar{\theta}^3-3\bar{\theta}^4,$$

where $\bar{\theta}$ is some mean value of θ. This is valid for small values of $(\theta-\bar{\theta})/\bar{\theta}$, that is, for temperatures close enough to $\bar{\theta}$.

The differential equation then becomes

$$kd^2\theta/dx^2-\theta(a^2k+8a\sigma\bar{\theta}^3)=a^2Hx-aA-6a\sigma\bar{\theta}^4,$$

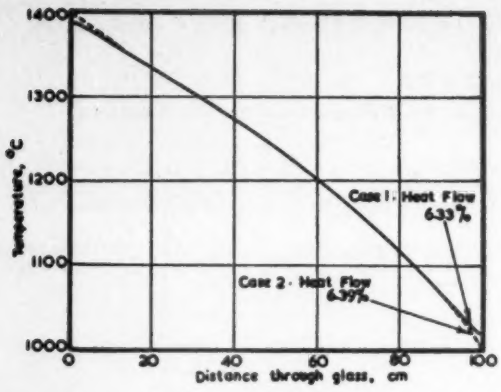

Fig. 2. Calculated temperature distribution through common window glass 100 cm thick separating blackbody zones at 1400°C. and 1000°C. The heat flow is expressed as a percentage of the heat that would be transferred by radiation if the glass were removed.

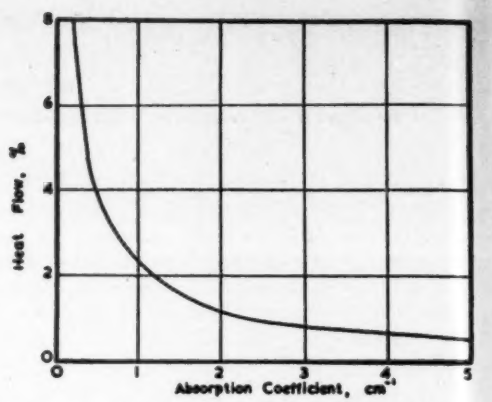

Fig. 3. Heat flow through glass 100 cm thick *vs* absorption coefficient of the hot glass for wavelengths near to 2μ. The curves for the two sets of boundary conditions are indistinguishable.

and the solution is

$$\theta=Be^{-mx}+Ce^{mx}-(a^2Hx-\sigma A-6a\sigma\bar{\theta}^4)/m^2k, \qquad (5)$$

where

$$m^2=a^2+8a\sigma\bar{\theta}^3/k.$$

A second approximation can now be obtained by differentiating this solution twice to give $d^2\theta/dx^2$ in terms of x for substitution into (4).

At this stage the boundary conditions have to be introduced, and the two forms of the problem must proceed separately.

Case 1. Heat Transfer to the Surfaces of the Sheet by Radiation Only. A total radiation of $\sigma\theta_1^4$ arrives at the surface $x=0$ from the blackbody surroundings per unit time. Of this, a fraction ρ is reflected and the remaining $1-\rho$ enters the glass. Also S is arriving from within the glass of which again a fraction ρ is reflected and the remaining $1-\rho$ penetrates the surface. Just within the glass, therefore, the total radiation flowing from left to right is $(1-\rho)\sigma\theta_1^4+\rho S$. The radiation boundary condition at $x=0$ is therefore

$$R=(1-\rho)\sigma\theta_1^4+\rho S.$$

Similarly,

$$S=(1-\rho)\sigma\theta_2^4+\rho R \quad \text{at} \quad x=d.$$

In this case, radiation is taken to be the only means of heat transfer to and from the faces of the glass, so that there is no conductive flow at the surfaces and the other two boundary conditions are $d\theta/dx=0$ at $x=0$ and at $x=d$.

Applying these conditions to (5) gives

$$-mB+mC-a^2H/m^2k=0$$

and

$$-mBe^{-md}+mCe^{md}-a^2H/m^2k=0,$$

from which $B=-a^2H/m^3k(1+e^{-md})$; $C=a^2He^{-md}/m^3k(1+e^{-md})$; but also from (5) $d^2\theta/dx^2=m^2Be^{-mx}+m^2Ce^{mx}$, so that substituting in (4) a second approximation to the solution is

$$aH[e^{-mx}-e^{-m(d-x)}]/m(1+e^{-md})+2\sigma\theta^4+ak\theta+aHx=A. \qquad (6)$$

In particular

$$aH(1-e^{-md})/m(1+e^{-md})+2\sigma\theta_0^4+ak\theta_0=A$$

and

$$-aH(1-e^{-md})/m(1+e^{-md})+2\sigma\theta_d^4+ak\theta_d+aHd=A,$$

Where θ_0 and θ_d are the temperatures at $x=0$ and $x=d$, respectively. If we use (2) and (3) and remember that $d\theta/dx=0$ on both surfaces, the radiation boundary conditions give

$$2\sigma\theta_1^4=H(1+\rho)/(1-\rho)-ak\theta_0+A$$

and

$$2\sigma\theta_2^4=-H(1+\rho)/(1-\rho)-ak\theta_d-aHd+A.$$

From the last four equations it follows that

$$H=\frac{\sigma(\theta_1^4-\theta_2^4)}{[(1+\rho)/(1-\rho)+\frac{1}{2}ad]}+\frac{ak(\theta_0-\theta_d)}{2+ad} \qquad (7)$$

and

$$H\left[\frac{1+\rho}{1-\rho}+\frac{a(1-e^{-md})}{m(1+e^{-md})}\right]=2\sigma(\theta_1^4-\theta_0^4)=2\sigma(\theta_d^4-\theta_2^4). \qquad (8)$$

These three equations can be solved for the three unknowns H, θ_0, and θ_d (by trial and error, in practice) after which any of the four preceding equations gives A, and the complete solution of the problem is then given by (6).

There is an element of uncertainty in (7) and (8) to the extent that the value of m depends on the choice of $\bar{\theta}$, which has been specified only as some mean value of θ. However, for the numerical cases worked out in the following, it turns out that the results vary by only one part in several hundred when $\bar{\theta}$ is moved over the whole range of possible values from θ_1 to θ_2.

The form of (7) is interesting. It shows the total heat flow to be made up of the radiative flow, plus the usual conductive flow but with d replaced by $d+2/a$. Thus if ad is large compared with 2, that is, the glass is thick or opaque, the heat flow is equal to the sum of the radiative and conductive flows calculated separately, but otherwise the total heat flow is less than this sum.

Case 2. Surfaces of the Sheet in Contact with the Blackbody Zones. In this case, the radiation boundary conditions are unchanged but the other two are replaced by $\theta=\theta_1$ at $x=0$ and $\theta=\theta_2$ at $x=d$.

The approximate solution (5) was obtained by replacing θ^4 occurring in the radiation terms by a linear expression of the form $a\theta+b_0$. The problem is therefore

symmetrical, and symmetry demands that $C=-Be^{-md}$ as before. Equation (5) then becomes

$$\theta=B[e^{-mx}-e^{-m(d-x)}]-(a^2Hx-aA-6a\sigma\bar{\theta}^4)/m^2k.$$

If we substitute the new boundary conditions that $\theta=\theta_1$ at $x=0$ and $\theta=\theta_2$ at $x=d$ and subtract, we obtain

$$B=(\theta_1-\theta_2-a^2Hd/m^2k)/2(1-e^{-md}). \qquad (9)$$

It follows that

$$d\theta/dx=-mB[e^{-mx}+e^{-m(d-x)}]-a^2H/m^2k$$

and

$$d^2\theta/dx^2=m^2B[e^{-mx}-e^{-m(d-x)}].$$

Substituting for $d^2\theta/dx^2$ in (4) gives, as a second approximation to the solution,

$$m^2kB[e^{-mx}-e^{-m(d-x)}]/a-2\sigma\theta^4-ak\theta-aHx+A=0, \qquad (10)$$

where of course B is given by (9).

In particular, at the two surfaces

$$m^2k(\theta_1-\theta_2-a^2Hd/m^2k)/2a-2\sigma\theta_1^4-ak\theta_1+A=0$$

and

$$-m^2k(\theta_1-\theta_2-a^2Hd/m^2k)/2a-2\sigma\theta_2^4-ak\theta_2-aHd+A=0.$$

Subtraction gives

$$m^2=2a\sigma(\theta_1^4-\theta_2^4)/k(\theta_1-\theta_2)+a^2.$$

The radiation boundary conditions, using the aforementioned expression for $d\theta/dx$, give

$$2\sigma\theta_1^4=k\frac{1+\rho}{1-\rho}\left[-mB(1+e^{-md})-\frac{a^2H}{m^2k}\right]+H\frac{1+\rho}{1-\rho}-ak\theta_1+A$$

and

$$2\sigma\theta_2^4=k\frac{1+\rho}{1-\rho}\left[mB(1+e^{-md})+\frac{a^2H}{m^2k}\right]-H\frac{1+\rho}{1-\rho}-ak\theta_2-aHd+A,$$

and subtraction gives

$$H=\frac{2\sigma(\theta_1^4-\theta_2^4)+ak(\theta_1-\theta_2)+mk(\theta_1-\theta_2)(1+\rho)(1+e^{-md})/(1-\rho)(1-e^{-md})}{2(1+\rho)/(1-\rho)+ad-2a^2(1+\rho)/m^2(1+\rho)+a^2d(1+\rho)(1+e^{-md})/m(1-\rho)(1-e^{-md})}.$$

A is then readily found from any of the four preceding equations, and (10) then gives the complete solution.

Numerical Examples and Discussion

The practical application that led to this work was that of calculating the rate of flow of heat through molten glass in a glass melting tank. A typical tank consists essentially of a large shallow refractory container heated from above to give a surface temperature in the melting zone of the order of 1400°C.; the bottom temperature is about 1000°C. and the depth of the glass of order 100 cm.

At these temperatures the peak of the radiant energy curve is at a wavelength of about 2 microns, so that a must be interpreted as the absorption coefficient of the hot glass for wavelengths near to 2μ. It is important that the measurement of absorption coefficient be made on hot glass because the absorption of a given glass at a given wavelength varies with the temperature of the glass. Measurements have been made in this laboratory on several types of glass by a method described by Merren.[3] These measurements suggest a value of a for wavelengths near to 2μ of about 0.3 cm^{-1} for a common window glass.

The aforementioned theoretical results have therefore been evaluated with the following values for the symbols:

$$d=100 \text{ cm.}\quad \theta_1=1673°K;\ \theta_2=1273°K;$$

$$a=0.3 \text{ cm}^{-1};\quad \rho=0.04;\quad k=0.0022 \text{ cal/cm °K sec};$$

$$\sigma=1.37\times10^{-12} \text{ cal/cm}^2 \text{ °K}^4 \text{ sec}.$$

Figure 2 shows the resulting temperature distribution through the glass for the two types of boundary conditions, and marked on the curves are the rates of heat flow expressed as percentages of the heat flow if the glass were removed; that is 100, $H/\sigma(\theta_1^4-\theta_2^4)$.

The striking feature of the results is that the heat flow is about 50 times what would be expected from conduction alone (namely, 1/8 per cent approx). Thus, though the primary radiation falling on the surface of the glass penetrates only a short distance (in 10 cm the intensity has fallen to $e^{-3}=5$ per cent), the process of absorption and reradiation within the body of the glass transports considerable quantities of energy. This agrees with practical observation on glass melting tanks.

H is plotted against a in Fig. 3 from which it can be seen that even with much higher absorption coefficients the radiant energy transfer is still considerable, and it is, in fact, greater than the conduction heat flow until a reaches about 15 cm^{-1}. However, the curve shows that the heat flow through a dark green bottle glass for which a might be as high as 5 cm^{-1} should be much less than through common window glass with a equal to about 0.3 cm^{-1}. This is also borne out by glassmaking experience.

The numerical example, whose result is shown by Fig. 2, is special in that the glass is so thick that ad and md are very large. The result could therefore have been inferred approximately from Eq. (5). That equation shows the first approximation to the solution to consist of the linear expression $\theta=-a^2Hx/m^2k+$constant with the additional terms Be^{-mx} and Ce^{mx} of significance only near the surfaces. In the body of the glass, therefore, the effect of taking account of reradiation has been approximately to replace k by $m^2k/a^2=k+8\sigma\bar{\theta}^3/a$. What might be called the additional thermal conductivity caused by reradiation is given by the term $8\sigma\bar{\theta}^3/a$, which with $\bar{\theta}=1473°K$. and $a=0.3$ cm^{-1} is 0.117 cal/cm °K. sec, that is about 50 times the ordinary thermal conductivity and in close agreement with the more exact calculation. The expression $8\sigma\bar{\theta}^3/a$ suggests that the heat flow caused by radiation is inversely proportional to a in agreement with the general shape of the curves of Fig. 3. It also shows the effect of temperature. As the temperature falls, the radiant energy moves to longer wavelengths where the absorption coefficient is in general greater, so that the expression $8\sigma\bar{\theta}^3/a$ will fall even more rapidly than $\bar{\theta}^3$. This very rapid change in effective thermal conductivity with temperature has been observed experimentally by McCauley[4] and is consistent with measurements of thermal diffusivity by Van Zee and Babcock.[5] At 500°C., for example, a must be interpreted as the absorption coeffi-

cient in the region of 4μ, which for common window glass might be about $5cm^{-1}$, so that $8\sigma\bar{\theta}^3/a$ amounts to no more than about 0.0014 cal/cm °K. sec and thermal conduction is more important than radiation. The effect described in this paper is therefore significant only at high temperatures.

It is of theoretical interest, though not of the same practical glassmaking significance, to examine the case when the layer of glass is not so thick. Figures 4 and 5 correspond to Figs. 2 and 3, respectively, but for a thickness of only 1 cm. Conduction would then give a heat flow of about 12 per cent, so that taking account of radiation with $a=0.3$ cm^{-1} multiplies this by about 8, and the approximate treatment for large ad is obviously no longer valid.

In this case, because ad is small, the temperature is almost uniform through the glass in Case 1 when the surfaces receive heat only by radiation. The increase in heat flow in Case 2, when the surfaces are maintained at 1440°C. and 1000°C., respectively, is therefore much greater than before.

Figure 5 shows the same general appearance as Fig. 3, but the fall is slower so that though at $a=0.3$ cm^{-1} the total heat flow is only about 8 instead of 50 times the conduction flow, the total is still about twice the conduction flow at $a=15$ cm^{-1} as before.

The heat flow of 104.6 per cent for $a=0$ in Case 2 is explained by the fact that the heat flow is expressed as a percentage of that due to radiation if the glass were removed. With $a=0$ the radiative flow is only slightly reduced by reflection at the surfaces, and with the boundary conditions of Case 2, a conductive flow is added, giving a total heat flow greater than 100 per cent.

Conclusion

The accuracy with which a is measured for any glass is not very high because a comparatively small experimental error in measured transmission through a sample affects the derived value of a considerably, and two samples of nominally similar glass can differ sufficiently in iron oxide content for their transmissions near to 2μ to differ appreciably. All factors considered, the value of a quoted for window glass at 2μ is probably subject to an uncertainty of about ± 25 per cent. In addition, the theory necessarily assumes a independent of wavelength over the range of wavelengths concerned, which is only very approximately true. This theoretical approach cannot, therefore, claim to give an accurate quantitative prediction of the heat flow through glass in a glass melting tank, but it is quite sufficient to show that absorption and reradiation of radiant energy plays a dominant part in the heat flow, and that the differences in transmission in the region of 2μ known to exist between different glasses can account for their very different heat transmissions at glass melting temperatures.

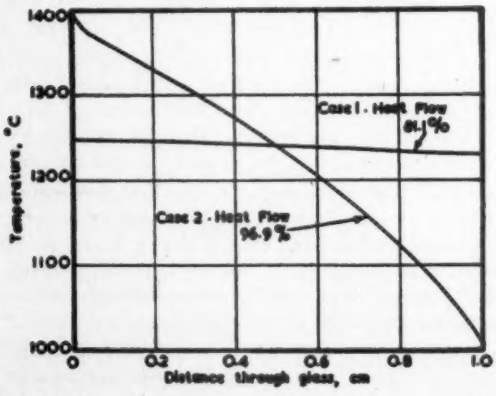

Fig. 4. Calculated temperature distribution through common window glass 1 cm thick separating blackbody zones at 1400°C. and 1000°C. The heat flow is expressed as a percentage of the heat that would be transferred by radiation if the glass were removed.

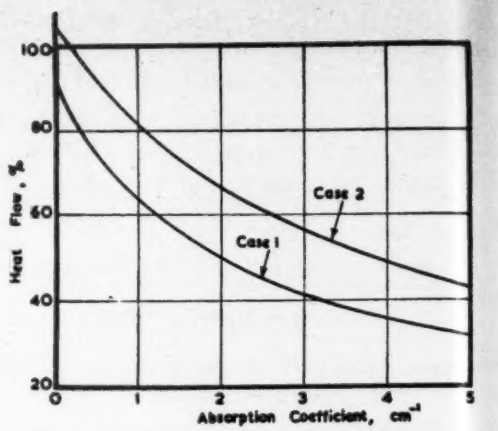

Fig. 5. Heat flow through glass 1 cm thick *vs* absorption coefficient of the hot glass for wavelengths near to 2μ.

Acknowledgment

The author wishes to thank the Directors of Pilkington Brothers Limited for permission to publish this paper and Miss M. Topping for help with the computation.

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EMHART ELECTS VICE PRESIDENT-OPERATION

The Board of Directors of Emhart Mfg. Company have elected Warren E. Hill as Vice President in charge of Operations, a new post.

Until recently, Mr. Hill was Executive Vice President of the Flexible Packaging Division of Shellmar Products Corporation. Mr. Hill's activities will be with all Emhart operating units, which include Hartford-Empire, Henry & Wright, and V & O Press Company divisions.

BRITISH FAIR TO INCLUDE GLASS INDUSTRY EXHIBITION

Britain's glass industry is to be well represented at the British Industries Fair at Earls Court Section in London between April 27 and May 8, 1953.

Manufacturers of pressed domestic glassware will show a wide range. Designs to suit all tastes will be on view, and the Fair will include a full range of oven ware and cooking ware to be used directly over a flame. Coronation souvenirs of many types will be shown and there will be a wide range of vacuum flasks and thermos jugs, lighting glassware, glass containers, medical, and scientific glassware.

Inventions and Inventors

Feeding and Forming

Glass Feeders. Fig. 1. Patent No. 2,623,330. Filed October 20, 1949. Issued December 30, 1952. Two sheets of drawings. Assigned to Emhart Manufacturing Company by Thomas W. Griffin.

This patent is an improvement in the feeder spout structure as illustrated in U. S. Patent No. 2,139,911.

The feeder is U-shaped as shown in Fig. 1. Improved heating facilities are accomplished by means of burner blocks 13 and 14 which supplement the front burner blocks 11 and 12. The former may be provided with spaced burner ports as indicated at 38. These ports may be extended transversely through the spout side burner blocks so that burners, indicated at 39, associated therewith may fire in directions transverse to the spout. The burners 39 are carried by the side portions 34 and 35 of the manifold 36. The location of the burner ports permits the positioning of forming machines or other structural parts close to the front of the feeder.

The patent contains seven claims and 10 references were cited.

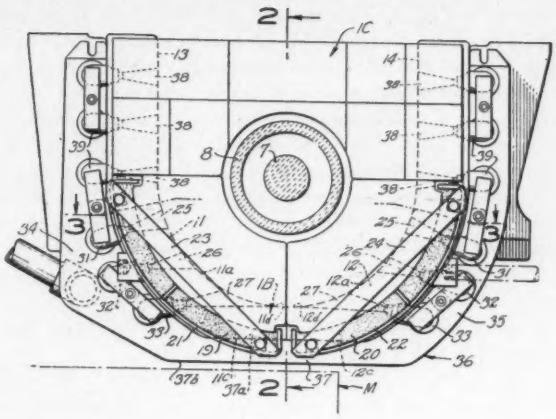


Fig. 1.

Furnaces

Refractory Insulating Brick. Patent No. 2,613,153. Filed May 17, 1949. Issued October 7, 1952. No drawings. Assigned to Johns-Manville Corp. by William L. Safford.

A superior refractory insulating brick was developed by use of the following molding batch expressed in dry weight proportions:

	%
Calcined alumina	28
Kaolin	47
Grog	22
Grained aluminum	3

Sawdust was included amounting to about 10% of the mixture.

Fired bricks were produced by this method and had the following properties:

Density	62-67 lbs./cu./ft.
Transverse strength or modulus of rupture	140-200 lbs./sq. in.
Compressive strength	180-400 lbs./sq. in.
Linear shrinkage after;	
24 hrs. @ 2800°F.	0.1% (approx.)
5 hrs. @ 3000°F.	0.5-3.7%
Thermal conductivity	3.60 B.t.u. in./hr. sq. ft./°F., mean temperature 2000°F.
PCE	above cone 37 (3308°F)

After the molding operation, the brick should be subjected to a slow drying operation at temperatures of 200-400°F., and the dry bricks are then fired in an oxidizing atmosphere to a final temperature of 2600°F. (pyrometric cone 16).

Such brick have proven to be volume-stable and resist spalling at temperatures as high as 3000°F.

The patent contains 12 claims and the references cited were: 413,238, Great Britain, 1934 and 587,595, Great Britain, 1944.

Furnace for Melting Glass. Fig. 2. Patent No. 2,616,-

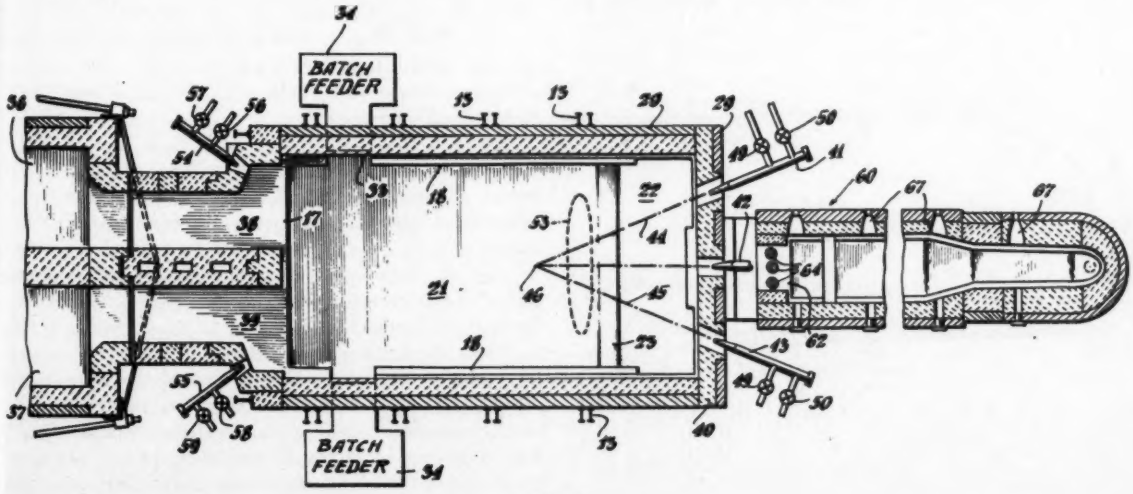


Fig. 2.

221. Filed April 26, 1950. Issued November 4, 1952. Two sheets of drawings. Assigned to Puerto Rico Glass Corporation by Jewell R. Hanson.

An improved "end fired" furnace for melting glass is shown in Fig. 2. This furnace provides in the front wall 40 a number of burners 41, 42, and 43 utilizing fluid fuel, usually gas and oil. These burners are so positioned and directed as to give a zone of highest temperature or "hot spot" 53. The furnace is also provided with a submerged throat 61 (not shown) at the same level of the bottom portion 22 of the tank. The submerged throat communicates with well 62 in the forehearth 60. The blocks forming the throat are exposed to the atmosphere on their outsides and thus are easily accessible for cooling, repair, or replacement. During the upward movement, the glass may be subjected to a mechanical stirring action of one or more stirrers 64. It is also possible to use more than one forehearth with the furnace.

The batch is supplied by means of batch feeders 34 at the rear and sides of the tank. The unmelted glass floats upon the molten glass and is held back of the "hot spot" by the rearward flow of the surface currents from the "hot spot" toward the rear end of the tank. In this way an effective separation is maintained between the melting zone proper for the tank and a "refining zone" which may be termed that portion of the tank between the "hot spot" and the forward end of the tank. By eliminating the nose portion of the conventional tank, this design is said to offer the advantages of high melting capacity in respect to the free surface area exposed to the heat of combustion.

The patent contains 11 claims and 11 references were cited.

Glass Wool and Fibers

Glass Slivers. Fig. 3. Patent No. 2,621,444. Filed April 19, 1949. Issued December 16, 1952. Two sheets of drawings. Werner Schuller, inventor.

An improved process for collecting glass filaments from a production point and drawing them out into a sliver or roving is shown.

The apparatus shown in Fig. 3 is provided at a proper position beyond the melting furnace. Glass filaments contact the drawing drum 4—in the illustrated example this position is on the upper half of the periphery of the drum. The device 6 collects the glass filaments continuously ar-

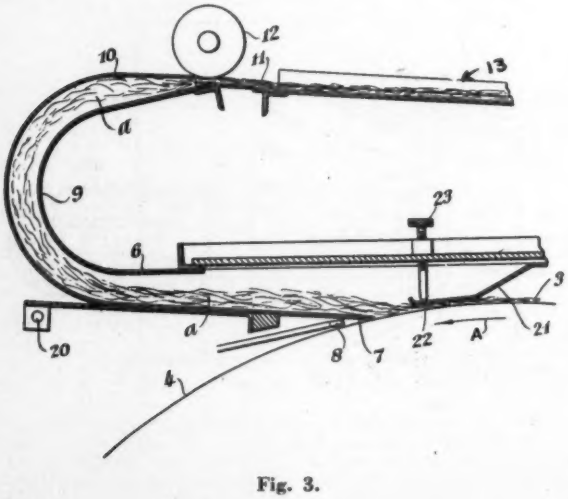


Fig. 3.

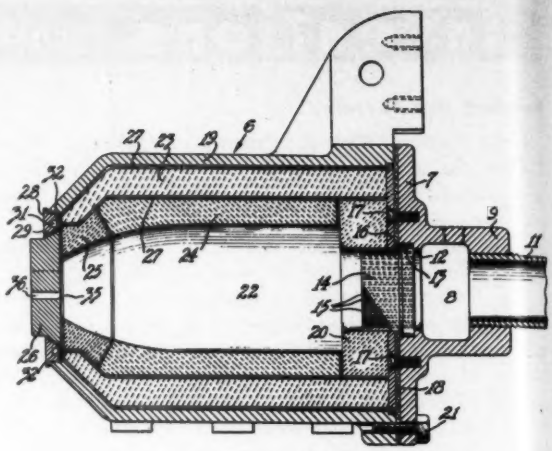


Fig. 4.

riving across the whole width of the drawing drum. The collecting device 6 is provided with a tongue or scraper 7, which, alone or in conjunction with a current of compressed air passing out of a nozzle 8 at a position below the knife and directed in the opposite direction to that of the rotation of the drawing drum 4, detaches the glass filaments 3 from the drum 4. The stream of air, created by the rotation of the drawing drum moving in the direction of the Arrow A, guides the glass filaments 3—lying substantially in the direction of the air stream—into the collecting device and moves them on in this same direction. At this position they are separated into staple fibers of different length under the action of the tongue or scraper 7. Figure 3 shows how the glass fibers are diverted by an elbow 9 and guided through a nozzle 10, so that a fiber lap 11, covering the entire width of the drum, emerges. The lap 11 is gripped and conveyed by one or more conveying and receiving rollers 12. Beyond the rollers 12 are provided collecting members 13 which direct the fiber lap into a sliver or roving (not shown).

The patent contains seven claims and the following references were cited: 1,923,183, Blum, Aug. 22, 1933; 2,048,651, Norton, July 21, 1936; 2,132,702, Simpson, Oct. 11, 1938; 2,398,808, Slayter et al., Apr. 23, 1946; 2,450,915, Powell, Oct. 12, 1948; and 2,460,899, Modigliani et al., Feb. 8, 1949.

Glass Wool. Fig. 4. Patent No. 2,614,619. Filed October 22, 1947. Issued October 21, 1952. One sheet of drawings. Assigned to Selas Corporation of America by Robert A. Fuller.

A high temperature gas burner that is adaptable to use in glass wool manufacture is shown in Fig. 4. The burner tip-on nozzle 26 has in it a port 35 which is substantially U-shaped. The port is provided with a horizontal portion 36 and two upwardly extending portions 37 and 38 (not shown) that converge toward their outer ends. The burner tip causes the hot gases of combustion from the combustion chamber 22 to pass through the port and take the form of a U, the angle of the legs causing the gases to converge. The pattern of the gases is substantially that of a hollow truncated pyramid with a small triangular opening in the top. Molten glass or slag dropping in front of such a burner is completely enveloped in the high temperature gases. Therefore, there is no possibility of the glass thread bouncing off or away

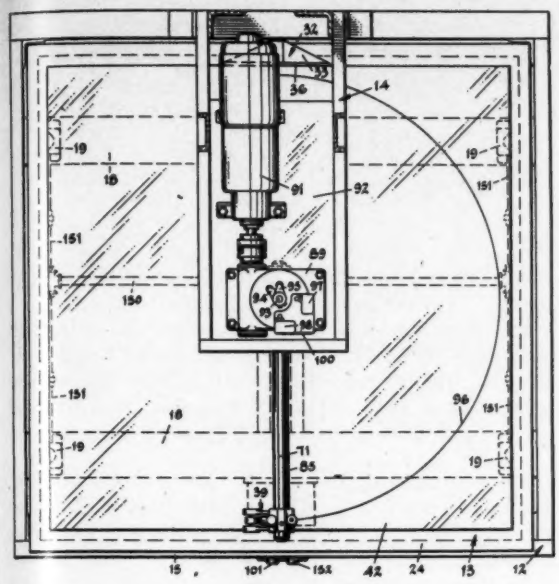


Fig. 5.

from the gases and, consequently, not being reduced in size. The high temperatures of the gases tend to remelt the glass or slag and blow it in a fine spray in the direction of gas flow. Space 23 is used for circulating cooling water so that the burner tip 26 and collar 28 will not become overheated.

The patent contains ten claims and the references cited were: 1,140,655, Bell, May 25, 1915; 1,689,551, Hammond, Oct. 30, 1928; 1,901,086, Cox, Mar. 14, 1933; 1,977,406, Powell, Oct. 16, 1934; 2,175,225, Slayter, Oct. 10, 1939; 2,178,871, Drill, Nov. 7, 1939; 2,367,119, Hess, Jan. 9, 1945; 2,427,545, Berger, Sept. 16, 1947; and 2,481,543, Stalego, Sept. 13, 1949.

Sheet and Plate Glass

Glass Cutting. Fig. 5. Patent No. 2,618,857. Filed November 14, 1947. Issued November 25, 1952. Three sheets of drawing. Assigned to Libbey-Owens-Ford Glass Co. by Arthur W. Goralske.

An improved method is presented for cutting glass shapes, especially circular sections, from glass sheets or plates.

A plan view of the cutting table is shown in Fig. 5. A glass sheet 42 is placed upon an elevator platform 12 after which the operator initiates an automatic work cycle. Immediately the glass sheet 42 is raised into engagement with the cutter 39. The desired inch dimension or diameter is determined by adjustments of scale 85. Rotation of head 39 produces a circular cut along the line 96. The cutting head 39 and bar 71 revolve at a high speed during the major portion of their rotation. When the cut nears completion, the speed of rotation is automatically reduced by the motor 91 to offset any abruptness caused by stopping of the cutter head. Immediately following the completion of the cut, the elevator platform descends and the glass sheet is removed. Other improvements in the adjustable mounting cutting table are understood from a study of the many drawings.

The patent contains two claims and 10 references were cited.

Miscellaneous Processes

Vacuum Flasks. Fig. 6. Patent No. 2,622,370. Filed August 10, 1949. Issued December 23, 1952. Two sheets of drawings. Arthème Dejardin.

A novel machine is shown that welds automatically a tube to the outer wall of vacuum flasks and thus eliminates many costly hand operations.

The machine, according to the invention, comprises a rotating plate or disc carrying a series of tongs or nippers for holding the bottles and driven through an element shaped as a Maltese cross, itself driven by a cam, in such a manner that each flask-carrying nipper travels from one position to the following position at a speed corresponding to the speed of the cam and remains in each position during a period equal to the duration of a revolution of the cam for engaging the cross member.

Fig. 6 shows diagrammatically bottle 3 and tube 7 in positions (c) prior to welding and position (e) after welding. The upper parts of the machine can be understood only after a study of the various drawings.

The patent contains three claims and the references cited were as follows: 918,669, Graybill, Apr. 20, 1909; 1,591,175, Mailey et al., July 6, 1926; 1,681,591, Millar, Aug. 21, 1928; 1,701,758, Mailey et al., Feb. 12, 1929; 1,735,027, Wetmore, Nov. 12, 1929; 1,897,488, Millar, Feb. 14, 1933; 2,272,927, Stager, Feb. 10, 1942; 2,385,302, Schellhaus, Jr., Sept. 18, 1945; and 2,447,569, Eisler, Aug. 24, 1948.

Powdered Glass. Patent No. 2,618,104. Filed December 5, 1949. Issued November 18, 1952. One sheet of drawings, none reproduced. Assigned to Corning Glass Works by Levi F. Goodrich.

This patent is a continuation of Patent No. 2,528,509 and is particularly concerned with the formation of a graded seal for joining parts respectively made of glasses differing materially in coefficient of expansion and softening temperature. In order to accomplish these results, the article, following its formation from several finely divided glasses, is successively fired from its lowest softening temperature portion. After fusing of the lowest softening portion, a cooling medium is directed against this portion as the next higher softening portion is being fired. As successively higher softening portions are vitrified, the cooling medium is directed against the previously fired portions to prevent their again attaining their softening temperatures. The completely fired article, while still in a workable condition, is subjected to a

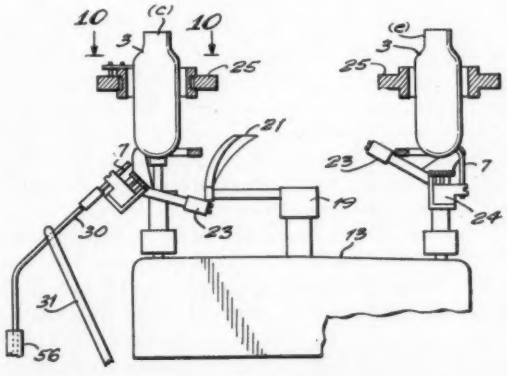


Fig. 6.

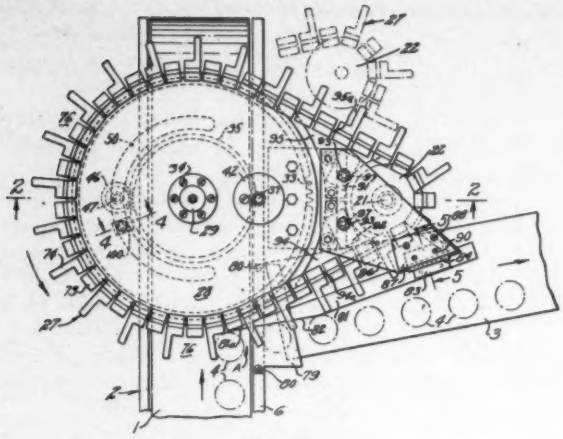


Fig. 7.

straightening treatment to eliminate any distortion.

The patent contains three claims and the references cited were: 2,336,227, Dalton, Dec. 7, 1943; 2,463,650, Snyder et al., Mar. 8, 1949; 2,494,582, Prokopec, Jan. 17, 1950; and 241,544, Great Britain, Apr. 1, 1926.

Glassware Transfer. Fig. 7. Patent No. 2,616,550. Filed February 9, 1950. One sheet of drawings. Assigned to Emhart Manufacturing Company by George E. Rowe.

Mechanism is described for transferring glassware, such as bottles, jars or the like, from one moving horizontal conveyor to a second adjacent moving horizontal conveyor.

In Fig. 7 an article conveyor 1 conducts glassware from a forming machine (not shown) to a second or cross-conveyor 3 which is also horizontal and moving in a direction away from the main conveyor. The articles are brought in a row to a transfer position A where successive articles are transferred to a second conveyor 3 by a transfer mechanism so that the articles are spaced uniformly in single file on the second conveyor. The transfer mechanism comprises a stationary horizontal supporting plate 5 disposed across the upper surface of a part of the conveyor 1. The details of operation of the transfer are aparent only after a study of the detailed drawing.

The patent contains 14 claims and the references cited were: 1,036,778, Baker, Aug. 27, 1912; 1,941,152, Noll, Dec. 26, 1933; 1,998,093, Oslund, Apr. 16, 1935; and 2,359,252, Seibert, Sept. 26, 1944.

Glass Solder. Patent No. 2,615,816. Filed November 10, 1949. Issued October 28, 1952. No drawings. Assigned to General Electric Company by Anne Patricia Dovey, Maurice Manners, and John Henry Partridge.

Glass solders employed for joining glass to metals or other materials, such as mica, often consist of lead oxide and boron oxide. Such glasses are readily blackened by heat due to reduction of the fire.

Improved solders have been made by substituting cadmium oxide for a part of the lead oxide content. The desirable range of compositions are by weight: 65% to 45% lead oxide (PbO), 10% to 35% cadmium oxide (CaO), and 25% to 20% boron oxide (B_2O_3). Minor amounts of silica (SiO_2) and zinc oxide (ZnO) are used up to 2% by weight. Such solders can be used at 490°C. to 530°C. with a coefficient of thermal expansion of (8.0 to 9.1) $\times$ 16 — ^{6} per degree centigrade.

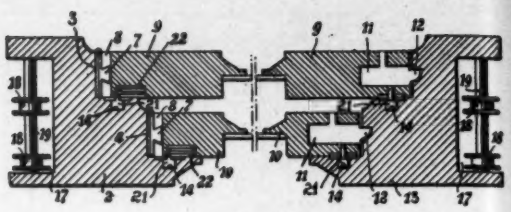


Fig. 8.

The patent contains seven claims and the references cited were: 1,673,679, Huber et al., June 12, 1928; 2,130,215, Young, Sept. 13, 1938; 2,210,489, Lemmens et al., Aug. 6, 1940; 2,231,718, Hill, Feb. 11, 1941; and 2,435,995, Armistead, Feb. 17, 1948.

Window Construction. Fig. 8. Patent No. 2,614,296. Filed December 7, 1946. Issued October 21, 1952. Three sheets of drawings. Celine Van der Pelen and Leo Freudenberg.

An improved method of window construction is shown in Fig. 8. The construction permits the sash to be lifted and lowered in a vertical direction and also to swing towards the room in order to facilitate cleaning and maintenance. The frame 2 of a double casement window is provided with sashes 9 and 10. Hinges 3 and 4 are mounted on the same side of the frame at the respective recesses. The hinges are arranged in different vertical planes and are offset relative to each other. Tongue 7 of the hinge is in slidable engagement with a corresponding groove of the dove-tail joint arranged in a member 8 secured to the sash 9 or 10, respectively.

The tongues 7 of the dove-tail joints extend throughout the entire height of the window frame 2, while the length of the member 8 and the grooves of the dove-tail joints arranged therein extend merely throughout the height of the sashes 9 and 10, respectively. This arrangement provides vertical movement of the sashes without lateral play. Moreover, the hinges 3 and 4 permit a swinging movement of the sashes 9 and 10 about their vertical axes towards the inside of the room.

The patent contains two claims and 14 references were cited.

Bond for Vitreous Enamels. Patent No. 2,615,836. Filed September 27, 1944. Issued October 28, 1952. One sheet of drawings, none reproduced. Assigned to Poor and Company by Allan E. Chester.

A method is described for improving the bond of vitreous enamels to metals, especially ferrous metals such as steel. Desirable results were obtained by electro-depositing such metals as arsenic, antimony, bismuth, cerium, lanthanum, and thorium in a thin, uniform coating on the steel surface prior to enameling. The deposition of metal is obtained from an electroplating bath containing salts of the desired metals. The advantage derived is an improved bond of enemal to metal with less chipping and cracking. The use of thinner vitreous coatings is also possible.

The patent contains one claim and 15 references were cited.

Vacuum Tube Manufacture. Fig. 9. Patent No. 2,618,904. Filed December 12, 1945. Issued November

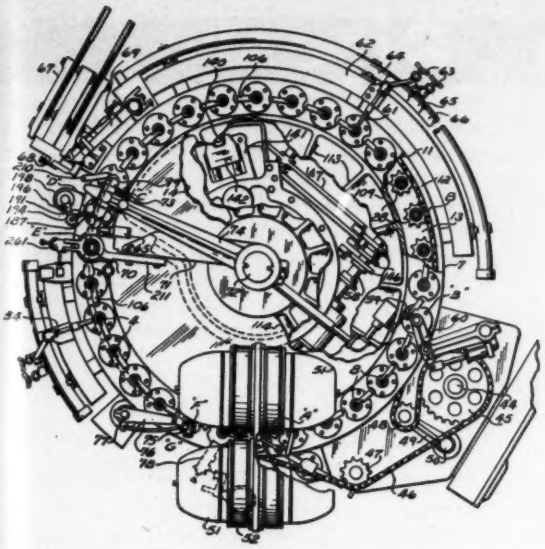


Fig. 9.

25, 1952. Nine sheets of drawings. Assigned to Sylvania Electric Products Inc. by Stanley J. Gartner.

This invention is an extension of Patent No. 2,588,977 involving the manufacture of radio receiving tubes and to the sealing and joining of small exhaust tubes to the cap or terminal header. The progress of forming is shown in Fig. 9, in which spindle 8 is started at station A and advanced counter clockwise to station B where glass disc 2 (not shown) is placed in position on the mold 15 (not shown). From station B to station C the spindles are intermittently advanced and heated. At station C the stem is added and sealed endwise to the disc 2. At station E the spindle is locked against rotation and a press 70, including mold, effects the sealing of the glass to metal around the pins and shapes the glass at the juncture of the stem 4 with the wafer. At station F rotation of the spindle is again stopped and stem 4 is removed by clamp 75 and deposited on a discharge chute. The details of operation and indexing of this complicated machine can be understood only after a careful study of the many drawings.

The patent contains 16 claims and 12 references were cited.

Refractory Compositions. Patent No. 2,614,050. Filed January 13, 1947. Issued October 14, 1952. No sheets of drawings. Assigned to Basic Refractories Inc. by Samuel Rusoff.

Bonding agents for magnesia and chrome refractories have been developed that do not lower the refractoriness of the product. "Bond-promoting" agents have been used and best results have been obtained by mixtures of polymerized sulphonic acids and polymerized alkali metal salts. The product is best illustrated by the following:

Refractory particles (magnesia and or chrome) 90-97%, dry powdered "bond-promoting" agents (as above) 0.3-2.0%, and dry powdered sodium silicate 2.0-8.0%.

The patent contains 11 claims and the references cited were: 2,004,545, Wolf et al., June 11, 1935; 2,406,909, Schoenlaub, Sept. 3, 1946; 2,407,725, Schoenlaub, Sept. 17, 1946; 573,410, Great Britain, Nov. 20, 1945; and Ser. No. 382,101, Passelecq et al. (A. P. C.), published May 11, 1943.

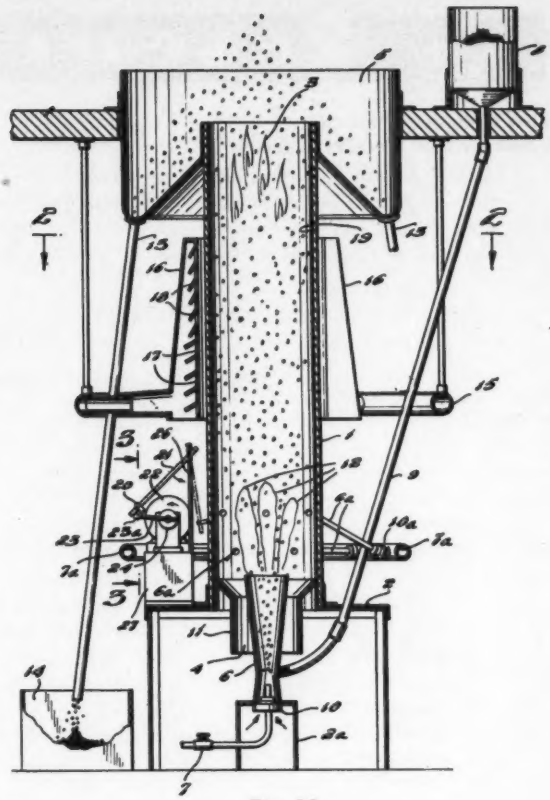


Fig. 10.

Glass Beads. Fig. 10. Patent No. 2,619,776. Filed March 5, 1948. Issued December 2, 1952. Two sheets of drawings. Assigned to Rudolph H. Potters, Jessie H. Potters, Paul E. Potters, Florence R. Potters, and Robert Potters by Rudolph H. Potters.

Glass beads of small diameter, .008" to .055", are produced by a procedure shown in Fig. 10. A draft tube approximately 15" to 18" in diameter and 12' in length is mounted in a vertical position. A gas burner 6 is mounted at the bottom of the draft tube. Glass particles are fed into the burner 6 from a hopper 8 by means of the tube 9. Glass particles may also be fed into the gas stream as it emerges into the bottom of the draft tube 1. The glass particles are carried out of the draft tube and fall in an umbrella-like spray from the top 3 of the draft tube into the hopper 5. In falling in this fashion, the glass particles cool and no longer stick together. From the bottom of the hopper 5 a plurality of conduits 13 extend to receptacles 14, in which the formed glass beads are collected.

The patent contains eight claims and the references cited were: 1,513,622, Manning, Oct. 28, 1924; 1,924,788, Hobson, Aug. 29, 1933; 2,044,680, Gilbert, June 16, 1936; 2,112,643, Baensch et al., Mar. 29, 1938; 2,300,042, Caldwell, Oct. 27, 1942; 2,334,578, Potters, Nov. 16, 1943; and 2,421,902, Neuschotz, June 10, 1947.

Glass Beads. Fig. 11. Patent No. 2,616,124. Filed May 13, 1950. Issued November 4, 1952. Two sheets of drawings. Assigned to Emhart Manufacturing Company by Aaron K. Lyle.

An improved method for the manufacture of glass

(*Continued on page* 100)

The Precipitation of Fluorides in Glassy Systems

It has been known for some time that a soda-lime-silica melt containing considerable amounts of fluorine precipitates sodium and calcium fluorides on cooling, a fact which is used commercially in the manufacture of opal glass.

That fluorides were the cause of opacity in such systems was suggested as far back as 1889, but it was not until 1926 that experimental proof was provided. Ryde and Yates found by X-ray diffraction analysis that, of a series of opal glasses from different manufacturers, all but one contained either sodium fluoride or calcium fluoride, or both. (The remaining one was believed to be

TABLE I (A)

Nature of Precipitate in Different Fluorine-containing Melts

Serial No. of Melt	*Composition*	*Nature of Divalent Oxide RO*	*Diffraction Patterns Observed*	*Appearance of Glass*
A1		BeO	None	Clear, greenish glass.
A2		MgO	$NaF + NaF \cdot MgF_2$	Streaky, grey opal.
A3		CaO	$NaF + CaF_2$	Dense, white opal.
A4		SrO	$NaF + SrF_2$	Very dense opal.
A5		BaO	NaF	Bluish opal.
A6	SiO_2, 71% by weight	6% CaO + 6%ZnO	$NaF + CaF_2$	Dense, white opal.
A7	Na_2O, 17% by weight RO, 12% by weight	ZnO	NaF	Chalky white opal, with characteristic "chalky" fracture.
A8	Added F 10 parts	CdO	NaF	Very dense opal.
A9	by weight/hundred of oxides	Fe calculated as FeO	NaF	Dirty green-grey, much crystalline precipitate.
A10		CoO	NaF	Strong blue color, much crystalline precipitate.
A11		NiO	NaF	Strong brown color, much crystalline precipitate.
A12		PbO	NaF	Dense white opal.

TABLE I (B)

B1		BeO	Unidentified	Very slight opalescence in greenish glass.
B2		MgO	$NaF + NaF \cdot MgF_2$	Very dense, uniform opal.
B3	SiO_2, 5.52 moles	SrO	$NaF + SrF_2$	Very dense opal.
B4	Na_2O, 1.78 moles RO, 1.00 moles	BaO	NaF	Grey but obscuring opal, much blue light scattering at edges.
B5	Added F 2.50 moles	ZnO	NaF	Very dense, uniform opal; "chalky" fracture.
B6		CdO	NaF	Very dense opal.
B7		PbO	NaF	Dense, white opal.

TABLE I (C)

	SiO_2, 71% by weight			
C1	K_2O, 17% by weight	MgO	$KF \cdot MgF_2$	Dense, bluish opal.
C2	RO, 12% by weight	CaO	$KF \cdot CaF_2 + CaF_2$	Rather greyish opal.
C3	Added F 10 parts by	SrO	SrF_2	Greyish opal.
C4	weight/hundred of oxides	BaO	BaF_2	Dense, streaky opal.

TABLE I (D)

D1	SiO_2, 5.52 moles	MgO	$KF \cdot MgF_2$	Dense opal.
D2	K_2O, 1.78 moles	CaO	$KF \cdot CaF_2 + CaF_2$	Very dense opal.
D3	RO, 1.00 moles	SrO	SrF_2	Dense opal.
D4	Added F 2.50 moles	BaO	BaF_2	Greyish opal.

opacified by gas bubbles.) They showed that the proportion of each salt was affected by the composition of the glass. In glasses of low-alkali content, only calcium fluoride was found. When both fluorides were present, their relative amounts depended on the calcium oxide and sodium oxide contents of the glassy matrix.

When part of the calcium oxide in a fluorine-containing soda-lime-silica melt is replaced by zinc oxide, there is a marked increase in the opacity of the cold glass. This has been said to be due to precipitation of zinc fluoride. As the suggestion had not been confirmed, it prompted an investigation into the different types of fluorides which could be precipitated in such systems. The results of this work were reported by R. J. Callow in the October 1952 issue of the *Journal of the Society of Glass Technology*.

Melts were made from pure materials, using sillimanite pots heated in a gas-fired furnace. About 0.1 per cent by weight of Al_2O_3 and a similar amount of SiO_2 were introduced due to corrosion of the pots. After the melts had been freed from undissolved material, they were held at 1450° for 1 hour. They were then cast on to a mild-steel plate and roughly annealed by holding them at 600° for 5 min. and cooling to 100° in about 16 hours. X-ray powder-diffraction spectrograms of the resultant glasses were obtained using standard industrial equipment, and these were compared with patterns obtained from the appropriate fluorides.

The crystalline materials found in the different glasses are listed in Table I. This is divided into four sections. Section A gives the glasses derived from the basic composition (SiO_2 71%; Na_2O 17%; CaO 12%: added F, 10 parts by weight/hundred parts by weight of oxides) by substituting other divalent oxides for the CaO on a weight by weight basis. The base composition is 3A. In glasses containing oxides of metal heavier than calcium, the molar fraction of divalent oxide is less than that of the base glass. Section 3 gives the glasses made by a molar substitution of divalent oxides. It was not practicable to prepare melts with the necessary amounts of iron, cobalt, or nickel oxides. The glasses in Section C are similar to the corresponding ones in Section A, but the Na_2O is replaced weight for weight by K_2O. Finally, those in Section D are similar to the corresponding ones in Section B, but K_2O replaces Na_2O in the equimolecular proportions.

The point of greatest technical interest in these results is the fact that no ZnF_2 is precipitated even when the ZnO replaces CaO mole for mol. The effect of the substitution on opacity is, however, very marked. The opacity is a function principally of the size and number of crystalline particles present and of the relative refractive indices of the crystalline and vitreous phases. Both the CaO and the mixed CaO-ZnO glasses (A3 and A6) contain a mixture of NaF and CaF_2 as the crystalline phase. The ZnO glasses (A7 and B5) contain only NaF. Although ZnO will affect the refractive index of the vitreous matrix, the effect of this on opacity will be slight. The change from NaF + CaF_2 to NaF will increase the opacity, although it is doubtful if the very large increase can be ascribed only to this cause. It is probable that the increase is also associated with an increase in the size or number of the crystalline particles present, and this is confirmed by the peculiar "chalky" fracture of the opals containing much ZnO, an effect almost certainly due to extensive crystal growth.

Another interesting feature is the behavior of the glasses containing BaO. With Na_2O, BaO produced rather poor opacities, showing the characteristic property of incompletely scattering opals of preferential blue scattering. The glasses contain NaF only, and should therefore have had more opacity than the CaO and mixed CaO-ZnO glasses containing NaF and CaF_2 together. Similarly, they could have been expected to be as good as the ZnO and the CaO glasses, which also contain only NaF. Here again, particle size and number could play an important part.

Although NaF is freely precipitated, it will be seen that KF is not present in any of the K_2O-containing opals. Although the double calcium and magnesium fluorides are formed, KF does not occur alone and, in the BaO glasses, BaF_2 is precipitated rather than KF. It is clear that much interesting information about melts of this type can be obtained.

INSULUX GLASS BLOCK MARKS TWENTIETH YEAR

More than 200 U. S. and Canadian distributors of Insulux glass block, attending the product's 20th birthday celebration, heard how engineering, advertising, and merchandising helped establish it as a success in the home, school, and industrial building fields.

Executives of Kimble Glass Company, producers of Insulux glass block, told how it was first introduced in 1933 as "another building material" but later, with scientific improvement, it became a light-directing block that revolutionized daylighting methods.

To introduce the new product to the public, Owens-Illinois Glass Company, Kimble's parent organization, erected the first all-glass block building at Chicago's Century of Progress Exposition. Since then, 125,000,000 Insulux glass blocks, enough to fill 25,000 freight cars, have been sold in this and 50 other countries. The world's largest installation, 750,000 glass blocks went into the temporary headquarters of the United Nations at Lake Success, N. Y.

E. B. Dennis, Kimble's Vice President and General Sales Manager, told the distributors that Insulux glass block sales would climb in 1953 as the company expanded its markets, while Oscar G. Burch, Owens-Illinois Research Director, said Kimble will spend about $3,500,000 for research, development, and engineering in 1953.

GLASSMEN NAMED TO GOVERNMENT ADVISORY POSTS

Announcement has been made of the election of John D. Biggers, President of Libbey-Owens-Ford Glass Company, as Chairman and Harold Boeschenstein, President of Owens-Corning Fiberglas Corporation, as one of the four vice chairmen of the Business Advisory Council for the Department of Commerce.

The 60-member Council, formed in 1933, is composed of an outstanding group of public-spirited leaders in industry, financial organizations, and general business, drawn from all sections of the country. It considers matters submitted by the President and the Secretary of Commerce.

Current Statistical Position of Glass

Employment and payrolls: Employment in the glass industry during November 1952 continued to rise and was reported at a preliminary 134,900. This is 1.8 per cent higher than the adjusted 132,500 persons reported during October. During November 1951, employment in the glass industry was 124,800, or 8 per cent less than for November 1952.

Payrolls during November 1952 also rose and were a preliminary $42,907,193. Compared with the previous month's adjusted $41,259,617, a rise of 3.9 per cent is shown. During November 1951, payrolls in the glass industry were $35,362,912, which is 21.3 per cent less than for November 1952.

Glass container production, based on figures released by the Bureau of Census, continued to fall off during December 1952 and was reported to be 8,250,347 gross. Compared with November production of 8,888,046 gross, a drop of 7.1 per cent is shown. During December 1951, production was 7,602,943 gross, which is 8.5 per cent less than for December 1952. At the close of 1952, glass container manufacturers had produced a total of 115,631,318 gross. At the end of 1951, they had produced a total of 117,692,359 gross, which is 1.7 per cent more than produced during 1952.

Glass container shipments during December 1952 also dropped off and were 8,115,977 gross. During November 1952, shipments were 8,545,981 gross, which is 5 per cent more than the December shipments. Shipments during December 1951 were 7,741,785 gross, or 4.8 per cent less than for December 1952. At the end of 1952, shipments of glass containers totalled 114,144,927 gross. Compared with 1951 shipments, which were 114,709,127 gross, a difference of only .4 per cent between the two years is shown. Year-end adjustments for 1952 may alter the final figure and when made available by the Department of Commerce, it will be reported in THE GLASS INDUSTRY.

Stocks on hand at the close of December 1952 were 10,166,279 gross, which is .7 per cent more than the 10,086,751 gross on hand at the end of November 1952 and 7.5 per cent more than the 9,452,721 gross on hand at the close of December 1951.

GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

	December, 1952
Narrow Neck Containers	
Foods	653,104
Medicinal & Health Supplies	915,601
Chemicals, Household & Industrial	612,112
Beverages, Returnable	445,826
Beverages, Non-returnable	37,716
Beer, Returnable	119,976
Beer Non-returnable	593,712
Liquors	628,079
Wines	333,163
Toiletries & Cosmetics	548,212
Sub-total (Narrow)	4,887,501
Wide Mouth Containers	
Foods	*1,987,004
Dairy Products	284,631
Medicinal & Health Supplies	326,911
Chemicals, Household & Industrial	144,025
Toiletries & Cosmetics	137,449
Packers' Tumblers	121,792
Sub-total (Wide)	3,001,812
Total Domestic	7,889,313
Export Shipments	226,664
TOTAL SHIPMENTS	8,115,977

*This figure includes Home Canning.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

		Production December 1952	Stocks December 1952
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	2,885,706	3,689,309
	Wide Mouth	*2,597,082	*3,241,798
Dairy Products		267,075	297,052
Beverages, Returnable		461,238	758,091
Beverages, Non-returnable		57,232	86,809
Beer, Returnable		167,331	212,786
Beer, Non-returnable		508,416	409,889
Liquors		789,735	913,951
Wines		402,594	407,623
Packers' Tumblers		113,938	148,971
TOTAL		8,250,347	10,166,279

*This figure includes Home Canning.

Automatic tumbler production during November 1952 was 5,190,508 dozens. This is 8.8 per cent less than the 5,696,134 dozens produced during October. During November 1951, production was 3,889,334 dozens. Shipments during November 1952 dropped 21.9 per cent to reach 4,693,424 dozens. This is a drop from the 6,012,130 dozens shipped during October. Shipments during November 1951 were 4,645,353 dozens. Stocks on hand at the end of November 1952 were 8,430,566 dozens, which is 4.9 per cent less than the 8,034,823 dozens on hand at the end of October. Stocks at the end of November 1951 were 11,228,354 dozens.

Automatic tumbler production for December 1952 continued to drop and was 4,959,897 dozens. This is 4.4 per cent below November production. Production during December 1951 was 3,799,888 dozens. Shipments of automatic tumblers also dropped and were 4,428,085 dozens, which is a drop of 5.6 per cent. Shipments during December 1951 were 3,352,290. Stocks on hand at the end of December 1952 were 8,910,823 dozens, which is 5.6 per cent more than at the end of November. Stocks at the close of December were 11,579,169 dozens.

Table, kitchen, and household glassware: Manufacturers' sales of machine-made table, kitchen, and household glassware during November 1952 were 3,665,760 dozens. This is 16.1 per cent less than the 4,374,327 dozens sold during October 1952. During November 1951, sales were 3,368,398 dozens. At the end of the 12-month period ending November 1952, sales were 40,430,863 dozens. This is 1.6 per cent higher than the 39,768,109 dozens sold during the 12-month period ending November 1951.

(*Continued on page* 102)

GLASS AND GLASSWARE

UNITED STATES PRODUCTION, IMPORTS FOR CONSUMPTION, AND DOMESTIC EXPORTS, BY KINDS
YEARS 1948 TO 1951

Glass and Glassware	PRODUCTION 1/				IMPORTS (Foreign Value) 1/				EXPORTS 1/			
	1948	1949	1950	1951	1948	1949	1950	1951	1948	1949	1950	1951
FLAT GLASS - Total	$275,000,000 2/	$260,000,000 2/	$400,000,000 2/	$450,000,000 2/	$1,052,068 3/	$1,102,898 3/	$6,365,249 3/	$10,830,949 3/	$11,548,652	$8,706,214	$7,112,496	$8,124,112
GLASS CONTAINERS - Machine and Hand Made Total	375,000,000 2/4/	375,000,000 2/4/	425,000,000 2/4/	470,000,000 2/4/	187,685 5/	251,463 5/	318,997 5/	525,515 5/	22,054,058 4/	19,587,271 4/	18,889,194 4/	24,342,690 4/
PRESSED AND BLOWN GLASSWARE												
Tumblers, Stemware, Table, Kitchen, Cooking and Art Ware												
Machine Made:												
Tumblers and stemware	30,061,000	31,598,000	38,273,000	40,596,000					2,265,558	3,222,355	3,354,606	6,584,390
Value added by cutters and decorators	3,000,000 2/	2,500,000 2/	3,000,000 2/	3,000,000 2/								
Other table, kitchen, cooking and art ware	42,845,000	39,861,000	45,197,000	48,441,000					8,581,241	6,653,032	4,679,336	7,216,994
Value added by cutters and decorators	1,000,000 2/	1,000,000 2/	500,000 2/	-								
Total Machine Made	76,906,000	74,959,000	86,970,000	92,037,000	8,252 4/	7,075 4/	14,536 4/	12,852 4/	10,846,799	9,875,387	8,033,942	13,801,384
Hand Made:												
Blown tumblers, stemware and other table, kitchen and art ware	18,388,000	16,156,000	15,741,000	16,312,000	2,094,000 6/	2,294,000 6/	2,779,399 6/	4,169,592 6/				
Value added by cutters and decorators	3,000,000 2/	2,300,000 2/	2,000,000 2/	2,600,000 2/								
Pressed tumblers, stemware and other table, kitchen and art ware	16,252,000	14,581,000	13,769,000	15,278,000	282,178 6/	289,382 6/	310,000 6/	463,288 6/				
Value added by cutters and decorators	1,500,000 2/	1,200,000 2/	1,200,000 2/	2,300,000 2/								
Total Hand Made	39,140,000	34,237,000	32,710,000	36,490,000	2,376,178	2,583,382	3,089,399	4,632,880	408,096	346,755	333,234	410,043
Total Tumblers, Stemware, Table, Kitchen, Cooking and Art Ware	116,046,000	109,196,000	119,680,000	128,527,000	2,384,430	2,590,457	3,103,935	4,645,732	11,254,895	10,222,142	8,367,176	14,231,427
Illuminating Ware												
Globes, shades, bowls, etc.	11,937,000	11,323,000	13,207,000	12,710,000	4,418	4,579	11,289	9,913	1,378,787	1,517,736	1,447,399	1,711,507
Lamp chimneys and lantern globes	2,159,000	1,607,000	2,189,000	2,301,000	1,406	133	241	102	868,643	684,803	690,649	737,289
Other including prisms, lenses, light bulb blanks, electrical tubing, television, radio and other electronic blanks	49,203,000	64,026,000	117,872,000	93,091,000	1,780,879 7/	1,858,260 7/8/	2,078,205 7/8/	2,387,848 7/	9/	1,887,044 9/	1,586,170 9/	1,887,845 9/
Total Illuminating Ware	63,299,000	76,956,000	133,268,000	108,102,000	1,786,703	1,862,972	2,089,735	2,397,863	2,247,430	4,089,583	3,724,218	4,336,641
Technical, Scientific, Industrial and Other Pressed and Blown Ware - Total (Includes Christmas tree ornaments, glass blocks, insulators, and miscellaneous types of glass)	71,782,000	63,266,000	78,448,000	96,210,000	896,850	1,447,707	2,344,546	2,980,305	11,418,302	7,303,283	7,952,739	10,493,025
Total Pressed and Blown Glass Industry	251,127,000	249,418,000	331,396,000	332,839,000	5,067,983	5,901,136	7,538,216	10,023,900	24,920,627	21,615,008	20,044,133	29,061,093
ALL OTHER GLASS AND GLASSWARE - Total (Includes optical glass and lenses, fibre glass, etc.)	90,000,000 2/	105,000,000 2/	110,000,000 2/	140,000,000 2/	131,070 10/	112,115 10/	124,343 10/	294,814 10/	125,057 11/	1,635,633 11/	1,659,612 11/	2,945,847 11/
GRAND TOTAL GLASS AND GLASSWARE	991,127,000 2/	989,418,000 2/	1,266,396,000 2/	1,392,839,000 2/	6,438,806	7,367,612	14,346,805	21,675,178	58,648,394	51,544,126	47,705,435	64,478,742

[1] Preliminary.

[2] Estimated and subject to revision.

[3] Relatively small imports of duty-free stained and painted glass windows and pictorial paintings on glass are included in another commodity group and are not shown on this table.

[4] Almost entirely machine-made.

[5] Largely hand-made.

[6] Almost entirely hand-made. Imports of kitchen articles are believed to be small. Imports of smokers' articles are included in another commodity group and are not shown on this table. Separation of these data into blown and pressed categories is based on trade estimates.

[7] Consists largely of prisms and chandelier parts.

[8] Includes about $350,000 of television tubes, imported as blown or decorated (coated) glassware; 1951 imports of such items were negligible.

[9] Included under Technical, Scientific, Industrial and Other Ware, except for light bulb blanks which are shown for 1949-1951 only.

[10] Imports of camera and projection lenses fitted to instruments are included in another commodity group and are not shown on this table.

[11] Includes ophthalmic glass and blanks and certain fibre glass products in 1949-1951. Exports of sun and goggle glasses and ophthalmic and instrument lenses are included in another commodity group and are not shown on this table.

Source: U. S. Department of Commerce in Collaboration with U. S. Tariff Commission

THIRD INTERNATIONAL GLASS CONGRESS ANNOUNCED

Plans are now being completed for the Third International Congress on Glass to be held in Venice, Italy, June 27 through July 5, 1953. A broad list of subjects to be included in the discussions has been made, publicity and applicant committees have been set up, and a schedule of technical sessions, plant trips, and sight-seeing tours in Venice has been arranged.

The number of subjects to be dealt with at this year's Glass Congress has been increased. If suitable papers are submitted, industrial administration and welfare and history and archaeology of glass will be discussed for the first time at this meeting. Reports, arising out of previous meetings, on (1) symbols, nomenclature, definitions, and literature of glass; (2) glass: chemical and physical properties, including methods of analysis and testing and constitution; and (3) fuels, furnaces, pyrometry, and refractory materials will be read. In addition, papers on form, design, and decoration of glass and engineering and process work will be considered. Authors who wish to submit papers to the Commission should see that final manuscript and abstract are in the hands of the Commission by March 28, 1953.

The schedule of activities has been arranged as follows: *Sunday, June 28,* Arrival in Venice and registration of participants; *Monday, June 29,* Inauguration of the Congress, visit to the Municipal Palace of Venice, reception by the Corporation of the City of Venice, gondola trip to churches and canals of Venice, visit to the Island of S. Giorgio Maggiore in the Harbor of St. Marks and to the "Fondazione Giorgio Cini"; *Tuesday, June 30,* Sessions of the Congress in the halls of the Palazzo Vendramin Calergi from 9:00 a.m. until noon and from 3:00 p.m. until 6:30 p.m.; *Wednesday, July 1,* Sessions of Congress from 9:00 a.m until noon and from 3:00 p.m. until 6:30 p.m., close of sessions from 6:30 p.m. until 7:00 p.m., plant trip to Vetrocke at Marghera planned for those interested at 11:00 a.m.; *Thursday, July 2,* Sessions of Congress from 9:00 a.m until noon and from 3:00 p.m. until 6:00 p.m., including concluding meeting of the General Assembly, concluding banquet of members of the Congress at the Grand Hotel Excelsior on the Lido; *Friday, July 3,* Trip to Murano in groups to one of the artistic glass factories and plant trip to Soc. Veneziano Conterie e Cristallerie, trip to ancient churches of Torcello, return to Venice; *Saturday, July 4,* Trip to Cortina D'Ampezzo, including visit to the central hydro-electric plant of the Societa Adriatica di Elettricita and sightseeing trip around the city, and return to Venice for conclusion of Congress.

BOOK REVIEWS

Thermochemical Methods in Silicate Investigation
By Wilhelm Eitel

The application of thermodynamic principles to silicate systems is familiar to glass technologists largely in the form of phase equilibrium diagrams. The many practical applications of thermochemical methods have been largely overlooked. First awareness of their utility was left to certain metallurgists in this country and in England who were studying slag systems. Only recently has the formation of a Basic Science Division in the American Ceramic Society provided a forum and a stimulus for ceramists beginning to explore this field (see, for example, the papers by W. J. Knapp, et al in the *Journal* and a review by Wygant and Kingery in the *Bulletin of the American Ceramic Society*, 1952).

Like Professor Eitel's earlier monograph on "Silicate Melt Equilibria," this book is written on too advanced a level to make for easy reading by a novice in the field. They do not fill the need for "cultural" texts designed to help the non-specialist form a broad picture of what the fields are and when and where he should call on the expert in thermochemistry for guidance. The emphasis is on problems in geochemistry rather than on practical problems in glass and ceramic production.

For glass technologists already possessing an understanding of the theory and utility of thermochemistry, Professor Eitel's text provides an excellent summary of (1) the experimental methods for determination of heats of reaction, fusion, crystallization (devitrification), and polymorphous inversions, as well as determination of reaction affinities; (2) utilization of the derived data in computing chemical equilibria and in interpreting structures; (3) numeral data on heats of formation, changes in state, heat capacities, and entropies.

Glass, as a state of matter, comes under discussion frequently throughout the text. The thermodynamic instability of glasses is emphasized, leaving all the greater wonder over the sluggish transformations which make possible the "frozen-in" state we call glass.

Rutgers University Press, New Brunswick, New Jersey; 132 pages; $4.75.

Elements of Ceramics
By F. H. Norton

The glass technologist who prejudged this book as too elementary for him from the title, table of contents, and publisher's prospectus is in for a pleasant surprise. Professor Norton has produced an excellent running summary of the present state of the entire range of ceramic technology. His presentation is greatly enhanced by the tables and illustrations specially prepared for this test and distinguished by conciseness, attractiveness, and originality.

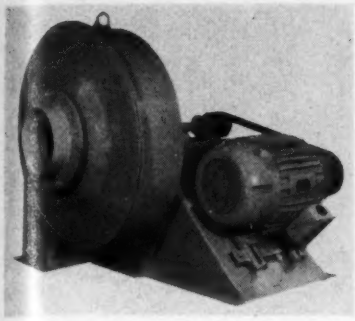
Even the chapters on clays and other ceramic raw materials, plastic flow and forming methods, ceramic bodies, glazes, enamels, and cements merit study by a specialist in glass. The chapters on the glassy state, glasses, and on color formation in glasses and glazes, brief and elementary though they necessarily had to be, may stimulate some fresh thinking about our favorite material.

"The glass industry," we are told, "amounts to approximately one-third of the whole ceramic industry in value of annual production. The glass producers are progressive in research and development, as well as in engineering, a fact that has done much to raise this industry to its present level."

The appendix describes six kilns for studio potters, tabulates typical body, glaze, and color compositions, and also includes ten tables of frequently-needed data. Even if you should decide that the book is too simple for you, this material should justify its purchase by getting off your neck those people who feel that any ceramist should be fully qualified to start them off on the hobby of pottery.

Addison-Wesley Press, Inc.; Cambridge 42, Mass.; 246 pages; $6.50.

New Equipment and Supplies



LARGE VOLUME BLOWERS

North American Mfg. Company, 4455 East 71st Street, Cleveland 5, Ohio, has added to its line of Series 300 Turbo Blowers a new large-volume blower, designed for economy of operation and maintenance.

With motor speeds of 1750 rpm, blowers are available with delivery up to 4700 cfm at 4 oz. pressure, or 4800 cfm at 8 oz. pressure. At motor speeds of 3500 rpm, the blowers range up to 7560 cfm at 16 oz. pressure. The Blowers are either direct connected or V-belt driven, and have a butterfly valve mounted on the intake to control volume.

NEW CLIPPER MASONRY SAW

Clipper Manufacturing Company, Suite 649, 2800 Warwick Kansas City 8, Missouri, has announced a new Model HD, incorporating several exclusive features.

A "Pressure Equalizer Spring" automatically cushions the blade, giving longer blade life. With the patented "Select-A-Notch," the saw operator can easily adjust the cutting head to any desired height. Other clipper features include a factory-sealed water pump that operates wet or dry; a patented Hinge-Lok Blade Guard which serves as a safety device and eliminates water spray when wet cutting.

QUICK-DISCONNECT MERCURY SWITCH

Minneapolis-Honeywell Regulator Company, Industrial Division, Wayne & Windrim Avenues, Philadelphia 44, Pa., has announced a quick-disconnect, motor cut-off mercury switch as special optional equipment for its strip chart Tel-O-Set recorders.

A glass enclosed, mercury toggle switch (SPST) is mounted on an angle plate near the cut-out in the top, right side of the recorder case. Here it is easily accessible. Power connections for the chart motor are made to a three-point terminal block on the same plate. Without disturbing the quick-disconnect switch, the recorder's drawer-type chassis may be partially withdrawn and held in this position for convenient chart-changing and adjustment. A special safety catch is provided to make this feasible. However, when the chassis is pulled out beyond the safety catch, it moves a lever, thus tripping the mercury toggle switch and instantly de-energizing the live lead to the chart motor. Without further precaution, the chassis can be safely disconnected and completely removed for servicing. There is no possibility of accidentally energizing the motor circuit during the removal. Once tripped, the spring-loaded switch remains in the "Off" position until the chassis is again partially replaced.

NEW PORTABLE SPECTROMETER AND VISUAL COLORIMETER

National Instrument Company, 5005 Queensbury Avenue, Baltimore 15, Maryland, has introduced a new Spectron Comparison Spectrometer suitable for qualitative analysis of the metallic elements. To identify any particular element, it is only necessary to note the wavelength of its spectral lines on a calibrated scale. Then, by referring to the table supplied with the instrument, the identity of the unknown element is established.

The optical system employed permits two spectra to be viewed simultaneously against a superimposed wavelength scale calibrated to read directly in mu. The spectrum of a known element may thus be compared with the unknown, further simplifying the analysis.

A cuvette attachment furnished with the spectron adapts it for use as a visual colorimeter for testing the absorption spectra of liquids. The spectron covers the entire visible range from 4000 to 8000 Angstroms. Dispersion C - F is 13°. The wavelength scale may be adjusted to the sodium line D and can be read with an accuracy of 1 mu.

G-E INFRARED METER

General Electric Company, Schenectady, New York, has announced a new infrared meter designed to measure radiant-energy intensities up to 10 watts per square inch. Designated as Type DW-69, the new G-E meter is especially suited for determining in a matter of seconds the intensity of high range, radiant-energy sources and for studies of infrared radiation effects concerning absorption and transmission properties of materials.

Typical applications include determination of drying-lamp field distribution, aiding the quality control of products that require infrared processing, and in experimental studies and analysis of paint-baking ovens.

CATALOGS RECEIVED

The Permutit Company, 330 West 42nd Street, New York 36, New York, has prepared a 28-page bulletin, Demineralization, including Silica Removal by Ion Exchange, to help explain one of the newer roles that ion exchangers are playing in industry.

The new bulletin, 3803, describes the chief applications, principles of operation, design features, advantages, recommendations, and specifications of the company's apparatus.

Acheson Colloids Corporation, Division of Acheson Industries, Inc., Port Huron, Michigan, has announced publication of a new, illustrated bulletin describing how 'dag' colloidal graphite has been used successfully to lubricate kiln cars at 450°F., oven conveyors up to 1200°F., and forging dies at over 2000°F.

The attractive four-page bulletin lists numerous applications at varying temperatures—melting point of glass at 2500°F.—discusses the product, giving a case study. Use of 'dag' in the production of bottles and tumblers is also discussed.

Link Belt Company, 307 N. Michigan Avenue, Chicago 1, Illinois, has published a new Folder No. 2437 describing Link-Belt Beyl friction clutches and clutch couplings. It includes schematic drawings and dimensional tables that enable the engineer to select the right clutch or clutch coupling for each requirement.

Beyl clutches are available in 10 standard sizes, ranging from 2¾ to 125 h.p. at 100 r.p.m. Positive action and easy adjustment are featured.

Also available through Link-Belt Company is a new, illustrated 16-page Book No. 2451 which discusses helical gear drives—their advantages, fields of application, and correct selection.

Full-page, cross-sectional views show in detail the design and construction features of both the double and triple reduction types. Installation photographs picture typical installations. All factors governing correct selection are described in detail. The right drive for any application can be chosen readily because horsepower ratings for all drives, in all ratios, for various input speeds, are shown in tabular form.

Load classes for 170 types of machines, arranged alphabetically from agitators to windlasses, are tabulated. Other tables give the maximum overhung loads for drives of various sizes. Principal dimensions of the various drives are shown.

Fischer & Porter Company, 6890 Jacksonville Road, Hatboro, Pa., has published a new catalog which describes a completely new P-4 Pneumatrol pneumatic controller for rate of flow, differential pressure, liquid level, viscosity, pressure and temperature applications.

The catalog describes in detail the action and components of the controller, illustrating construction in detail.

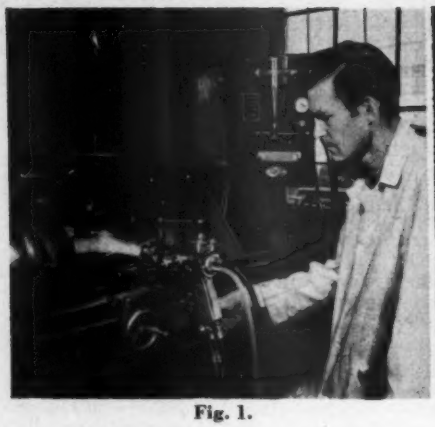


Fig. 1.

Fig. 2.

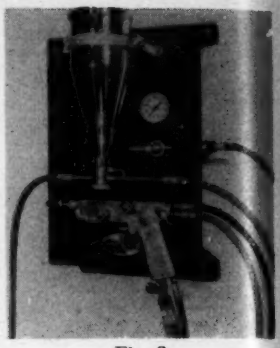


Fig. 3.

LIFE INCREASED, MAINTENANCE COSTS CUT BY SPRAYWELDED HARD FACING ALLOY SURFACES

Metal plungers for molten glass, protected from heat and wear by Colmonoy Spraywelded hard-facing alloy surfaces, are said to be functioning up to 54 times longer than conventional cast iron plungers in the equipment of eight leading American manufacturers of glass containers. The hard-facing alloy is applied by a powder metal spraying unit in a process that provides a non-porous, fusion bonded, wear and heat resistant surface on the plungers up to 0.060 in. thick.

Performance tests on spraywelded glass plungers reveal that they cost as little as one-eighth as much per hour as unprotected cast iron plungers. In addition, much less lubrication is required for spraywelded plungers, thus avoiding surface contamination in containers which is often caused by excessive use of lubricants. The alloy surface on the plungers can be easily renewed by respraying and re-fusing when wear occurs after long periods of operation.

The prolonged life of spraywelded plungers has led to long continuous operation for container manufacturing equipment. Quality of the glass containers, it is stated, has been further improved by smoother inner surfaces resulting from the use of spraywelded plungers which retain their smooth surfaces for long periods of time.

No plunger design changes are necessary to apply the Colmonoy Sprayweld process to the hard-facing of conventional glass plungers with the exception that mild steel instead of cast iron is specified as the plunger base material. In the first step, the plunger surface is undercut to the depth of the overlay. Next, the surface is blasted with steel grit to provide a good mechanical bond between the base metal and the Colmonoy No. 6 Alloy that is applied in the subsequent spraying operation. Next, the grit-blasted plungers are chucked in a lathe and rotated while the hard-facing alloy is applied by the spraywelder pistol, Fig. 1. A smooth overlay of alloy can be made on the cylindrical plunger within 0.020 in. of finish dimensions.

The mechanically bonded alloy surface is then fused to the plunger base metal by rotating the plunger in the same lathe set-up, see Fig. 2, under an oxyacetylene flame. The hard-facing alloy is thus molecularly bonded to the base metal in a non-porous deposit. Fusion-bonded, hard-faced surfaces of the plungers are machined in a lathe with a carbide tool before installation in the container molding machine.

To be able to make use of the spraywelding process, a manufacturer needs, in addition to standard maintenance equipment such as a lathe and grit-blasting machine, only a Spraywelder unit, oxygen and acetylene tanks, and a compressed air source for the spray unit capable of delivering 15 cfm of dry air at a minimum pressure of 60 psi.

The Colmonoy Spraywelder, Fig. 3, consists of a pistol, alloy powder hopper, carburetor, panel, hoses, and an air regulator and air filter attached to the back of the panel.

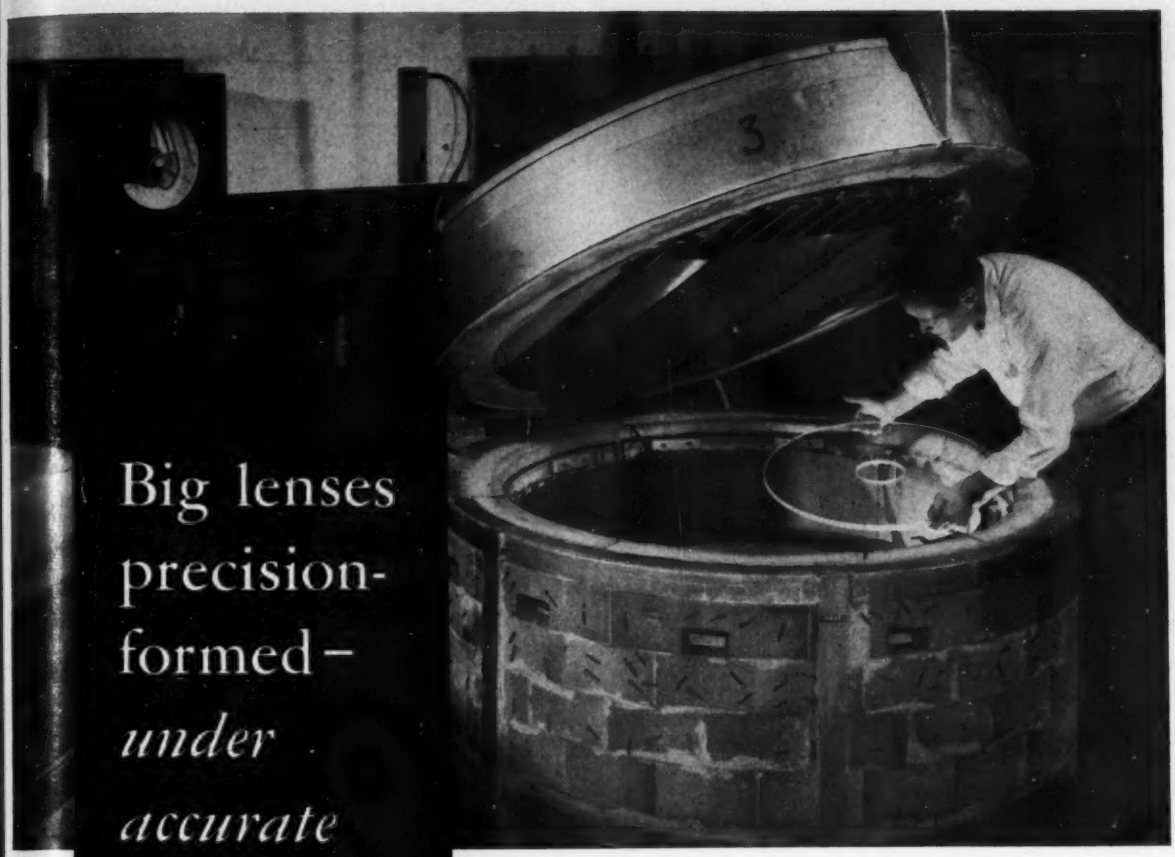
The alloy, which is applied to the glass plungers by the spraywelding process, has high resistance to oxidation at elevated temperatures, as well as remarkable metal-wetting properties. It also has what is known as a high plastic range. This means that the alloy is plastic or 'mushy' over a wide range of temperature (1850° F. to 2050° F.), enabling it to be bonded to steels, stainless steels, and some cast irons and copper alloys without flowing or losing its shape. This latter property is of great help in maintaining uniform non-oxidizing alloy overlays on shapes like those of glass plungers.

Until hard-surfacing techniques were applied to glass plungers, the best plunger material from an economic standpoint was cast iron. Although it is possible to bond Colmonoy No. 6 Alloy satisfactorily to some cast irons by spraywelding, mild steel is now being recommended for the plunger base material for maximum performance and life.

By specifying a mild steel such as SAE 1020 for the plunger material, failures resulting from non-uniformities that often occur in iron castings are avoided and maximum plunger life is assured. According to one leading glass container manufacturer, a mild steel plunger costs only about 10% more than a similar cast iron type to prepare.

Because spraywelding is much faster than hand welding up to certain thicknesses, and because the spraywelding equipment can also be used for metallizing (non-fused mechanical-type bond), this type of equipment can find broad use in the glass industry outside of the applications described here.

Two other alloys, Colmonoy Nos. 4 and 5, are also available for spraywelding. They have Rockwell C hardnesses ranging from 35 to 50. These alloys, as well as No. 6, can be used in the resurfacing of machine parts such as shafts, cams, and other types where extreme resistance to abrasion, heat, erosion, and corrosion is required.



Big lenses precision-formed—*under accurate* ElectroniK *control*

Glass blank is formed into a lens in this furnace . . . under automatic time pattern control by ElectroniK Integral Cam Programmer mounted at left.

REFERENCE DATA: Write for new Catalog 1530, "ElectroniK Controllers"...and for Bulletin 1502, "Cam Operated Program Controllers".

A UNIQUE MEANS for producing 22-inch diameter lenses for theatre television projection systems has been developed by American Optical Co. These lenses must be formed with extreme accuracy in order to produce a sharp, undistorted picture.

Precise temperature control, using *ElectroniK* instruments, is a key factor in the forming operation. The lens blank is placed on an accurately ground refractory block, slowly heated in an electric furnace to forming temperature, annealed, and gradually cooled. During the full 36-hour cycle, temperature can change only at definite rates, to prevent cracking of the block and lens.

ElectroniK Program Control brings furnace temperature accurately up and down at exactly the prescribed rate for each stage of the process without need for human assistance. A single instrument does the entire job. The desired cycle, cut on a clear plastic cam, is precisely reproduced from batch to batch. Operators can readily check the progress of the cycle at any time, just by glancing at the instrument chart record.

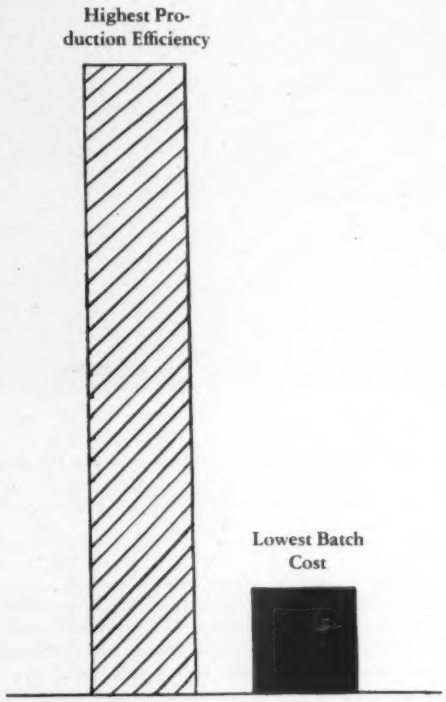
Whether your production requires the simplest or the most complex temperature control, you can be sure of getting the right instrumentation, correctly applied . . . from Honeywell. Call our nearest engineering representative today . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4521 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

CALUMITE

When you have a choice between two or more raw materials whose function in the batch is similar, what are the deciding factors? We believe you will agree they are:



The relationship of efficiency to cost when Calumite is used for the production of colored glass is in the proportion illustrated.

Your inquiries are solicited.

The Calumite Co.
HAMILTON, OHIO

C. P. OVERMYER, SR. KILLED IN AUTOMOBILE CRASH

As briefly reported in the January issue of THE GLASS INDUSTRY as it went to press, C. P. Overmyer, Sr., President of Overmyer Mould Company, Inc., was killed as the result of injuries sustained in a three-car automobile accident near Zanesville, Ohio.

Mr. Overmyer's first contact with the glass industry came during his school days when he was employed as a glasshouse roust-about. Familiarizing himself with the industry, he took advantage of an opportunity to learn the mould making trade and began his apprenticeship in 1901. In 1904, the American Flint Glass Workers Union admitted him to the union as a journeyman mould maker. He spent the next three years with the Bolt Glass Company and the Zanesville Mould Company.

In the ensuing years of 1907 and 1908, Mr. Overmyer left the trade and entered business for himself, forming a partnership under the name of Garver-Overmyer Packing Company. This business was concerned with making and marketing hominy in the local grocery stores. In 1909, he returned to the trade as a mould shop foreman with the Elk Flint Bottle Company, later becoming a boss mould maker for the Marion Flint Bottle Company. His next move brought him to Winchester, Indiana, where he accepted a position as mould shop foreman and master mechanic with the Woodberry Glass Company.

Selected to assist in the development of glass mould equipment for the first Automatic Lynch Glass Blowing Machine, the success achieved and knowledge gained during this project moved him to begin thinking of his own mould manufacturing company. A partnership was entered under the name of White-Overmyer Mould and Machine Company in 1920. In 1922, the Overmyer Mould Company was chartered and J. H. White sold his interest to Mr. Overmyer, making him sole owner. From the very modest beginning of only three employees, the Overmyer Mould Company has enjoyed a steady and healthy growth and has gradually expanded to meet the demands of the sprawling glass industry which have grown all over the world.

Expansion of the company included the opening of a branch plant in Greensburg, Pa., in 1934, and a Western Division at South Gate, California, in 1945.

• The Dominion Glass Company, Limited, recently noted its third banquet of the Quarter Century Club. The Club now totals 523 members with an average length of service with the company of 31 years.

• L. A. Watts has been named General Manager of Sales of the Eastern Division of The Colorado Fuel and Iron Corporation.

the MAGIC GENIE of industry

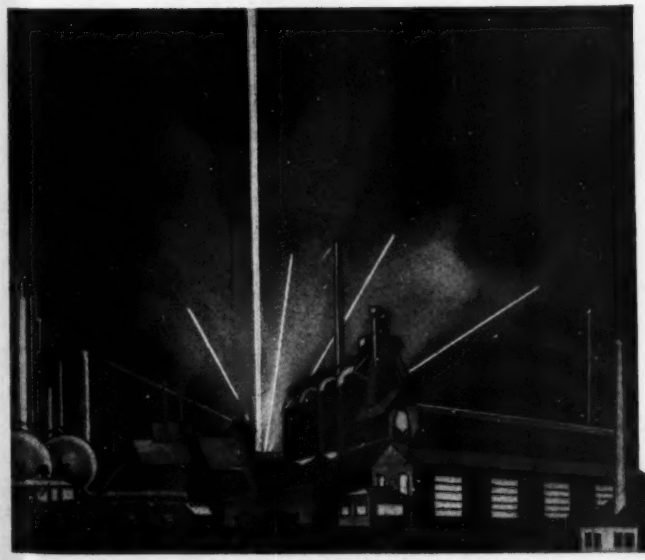
• Like the magic genie of old, Harshaw Fluorides work capably and efficiently for many industries. They are used advantageously in numerous operations. The top ranking of Harshaw Fluorides is the result of rigidly controlled uniformity and quality.

A comprehensive group of Harshaw Fluorides is listed below

Ammonium Bifluoride	Hydrofluoric Acid Aqueous
Ammonium Fluoborate	Hydrofluosilicic Acid
Antimony Trifluoride Sublimed	Inorganic Fluorinating Agents
Barium Fluoride	Potassium Bifluoride
Bismuth Fluoride	Potassium Chromium Fluoride
Boron Trifluoride	Potassium Fluoborate
Boron Trifluoride Complexes	Potassium Fluoride
Chromium Fluoride	Potassium Titanium Fluoride
Fluoboric Acid	Silico Fluorides
Fluorine Cells	Sodium Fluoborate
Fluorinating Agents	Zinc Fluoride
Frosting Mixtures	
Hydrofluoric Acid Anhydrous	

Available upon request . . . M. C. A. Safety Data Sheets SD-25 and H-10 furnishing essential information for safe handling and use of hydrofluoric acid.

HARSHAW FLUORIDES



THE HARSHAW CHEMICAL CO.

1945 E. 97th Street • Cleveland 6, Ohio

Branches in Principal Cities

GEORGE MAC NICHOL ELECTED L-O-F EXECUTIVE VICE PRESIDENT

George P. MacNichol, Jr., a fourth generation member of a pioneer American plate glass family and Vice President in charge of Sales since 1930, was elected Executive Vice President of Libbey-Owens-Ford Glass Company by the directors on recommendation of John D. Biggers, President. Mr. MacNichol succeeds to the post which was left vacant at the retirement of the late D. H. Goodwillie a year ago.

Mr. Biggers stated that Mr. MacNichol had been given added executive responsibilities for the Liberty Mirror and new Fiber Glass and Corrulux Divisions of the company within the last two years, in addition to his guidance of sales policies of the company.

Mr. MacNichol, born in Wyandotte, Michigan, completed his formal education at University of Michigan and Yale University, and joined the company as Assistant Treasurer in 1920. Following in the footsteps of his father, he served as Treasurer and Sales Manager of the former Edward Ford Plate Glass Company. Ever since Libbey-Owens and Ford Plate joined forces in 1930, he has been Vice President in charge of Sales.

KAISER ALUMINUM RELEASES INDUSTRIAL MOTION PICTURE

The Chemical Division of Kaiser Aluminum & Chemical Sales, Inc., has released the first comprehensive industrial motion picture in color showing the manufacture of basic refractories.

The 30-minute, 16 mm. sound film, entitled "Bricks from the Sea," follows the company's refractory brick and ramming mix production from the extraction of magnesia from the Pacific Ocean by processing 13,000,000 gallons of seawater daily to the use of refractories in the production of basic products.

O-I FORMS SUBSIDIARY

Owens-Illinois Glass Company has formed a wholly-owned subsidiary called Owens-Illinois Inter-America Corporation, which will export products of the parent company to countries in the Western Hemisphere. O. R. Hecht, who joined the company in 1927, is President of the new subsidiary.

Sales in other countries will be handled by the parent company's International Division, also under the managership of Mr. Hecht. Formation of the Inter-America Corporation combines in one organization the responsibility for export sales of all O-I products in the Western Hemisphere.

HOMMEL SERVICE AWARDS

Among the thirty-two employees receiving service pins from Ernest M. Hommel, President of The O. Hommel Company, were twenty men and women receiving 5-year pins; five given 10-year pins; four given 15-year pins; one receiving a 20-year pin; and two others receiving 25-year pins.

Mr. Hommel thanked the recipients for their service and commented on the spirit of cooperation which has prevailed throughout the year just passed.

LOOK
AT THESE ADVANTAGES IN USING
BORAX
• Small amounts of F. M. Smith Brand Borax give faster production through more rapid melting and fining. Lower melting temperature saves on fuel.
Boric Oxide in glass decreases coefficient of expansion thereby increasing thermal resistance of end products.
Glass containing Boric Oxide is more elastic (physically stronger), stands up better to the action of steam, hot water, cold water, alkaline and acid solutions.
Write for complete information and technical assistance on the use of F. M. Smith Brand Borax and Boric Acid in glass manufacture.
Stauffer CHEMICALS
SINCE 1885
Nitrate of Potash-Sulphurs
STAUFFER CHEMICAL COMPANY
420 Lexington Avenue, New York 17, N. Y. 221 N. La Salle Street, Chicago 1, Ill.; 824 Wilshire Boulevard, Los Angeles 14, Calif.; 636 California Street, San Francisco 8, Calif.; Box 7222, Houston 8, Texas; No. Portland, Ore.; Apopka, Fla.; Weslaco, Tex.

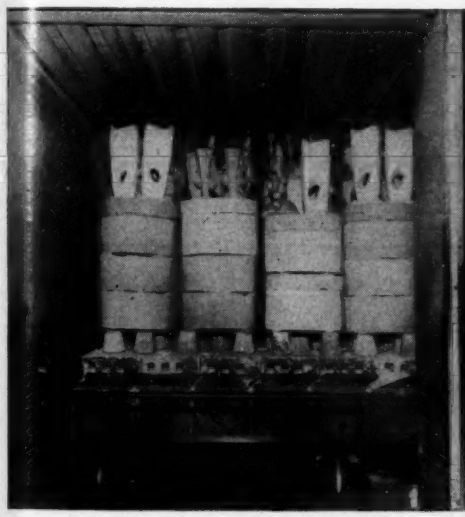
GAS
THE MODERN FUEL
FOR ALL INDUSTRY

GAS assures PRECISE TEMPERATURE CONTROL

for production of 250,000 art pottery pieces per month

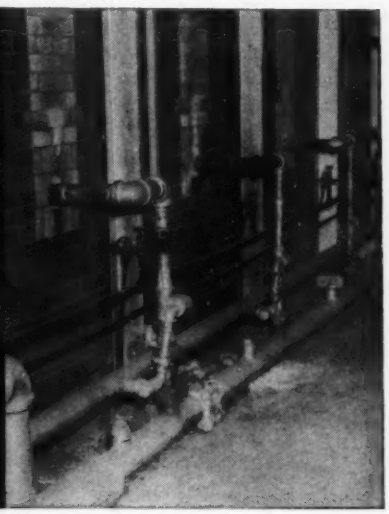
at The HAEGER POTTERIES, INC. (World's Largest Art Pottery)

Dundee, Illinois & Macomb, Illinois



A carload of decorative pottery enters a Gas-fired kiln at The Haeger Potteries, Inc., Dundee, Illinois, for a finish firing operation. Gas kiln operates on 24-hour schedule.

Easily-controlled Gas burners on kiln provide the exact temperatures required to fire the many ceramic products at Haeger.



The Gas-fired kiln at The Haeger Potteries, Inc. is on a 24-hour schedule, operating at 1850° F. This temperature is readily maintained day after day, because Gas temperatures are easy to control precisely.

A wide variety of color and glazes are used on the 12,000 Art Pottery pieces completed each day, which necessitates great care in proper placing of pieces on the kiln car, and requires dependable, accurate control of the firing itself.

Every step in the preparation of the beautiful ceramic pieces (vases, figurines, lamp bases) made by Haeger, from the drawing board to the firing in the Gas kiln, is responsible in some part for The Haeger Potteries, Inc., being recognized as the "World's Largest Art Pottery."

In the ceramics field and glass industry, Modern Gas-fired kilns, lehrs and other Gas equipment prove daily that Gas is The Modern Fuel for the industry, because Gas is versatile, because temperatures are precisely controllable, and especially because Gas Equipment fits readily into production-line technique. Get the facts today from your Gas Company Representative.

MORE AND MORE
THE TREND IS TO GAS
FOR CERAMIC FIRING

AMERICAN GAS ASSOCIATION • 420 LEXINGTON AVENUE, NEW YORK 17, NEW YORK

WYANDOTTE ELECTS VICE PRESIDENT-TREASURER

George W. Schwarz, since 1948 Vice President-Controller of Wyandotte Chemicals Corporation, has been promoted to Vice President and Treasurer, Robert B. Semple, President, has announced, following the year-end meeting of the Board of Directors.

In assuming supervision of the financial administration of the nationwide chemical company and its transportation and mining subsidiaries, Mr. Schwarz relinquishes the controllership after a long career in accounting that has brought him many honors from professional societies, including membership on the board of directors and a vice presidency of the Controllers' Institute of America and a vice presidency of the National Association of Cost Accountants, an office he currently holds.

The functions of treasurer have been handled by Ford Ballantyne, Sr., who will continue to serve as Vice President and Secretary of the company, offices he has held for many years.

Mr. Schwarz, a resident of Plymouth, Michigan, and a native of Brooklyn, N. Y., is a certified public accountant and has served in various accounting capacities with industrial corporations in the Detroit area. In 1925, he joined the staff of Ernst and Ernst, public accounting firm, and in 1938 moved to Wyandotte as controller.

COLORADO FUEL & IRON NAMES VICE PRESIDENT-SALES

H. C. Allington has been elected Vice President in charge of Sales of the Eastern Division of The Colorado Fuel and Iron Corporation, according to an announcement by F. S. Jones, Vice President-Sales of the firm.

Mr. Allington, whose headquarters will be in New York City, will supervise sales in the Eastern Division of all products manufactured by Colorado Fuel and Iron and its subsidiaries, including the recently acquired John A. Roebling's Sons Corporation.

Mr. Allington has been General Manager of Sales of the Wickwire Spencer Steel Division since 1947. Before joining Wickwire Spencer as a sales executive in 1943, he was associated with the Sharpsville Boiler Works and the American Machine and Metals, Inc.

ERRATA: In commenting on the paper given by R. R. Shively, B. F. Drakenfeld & Co., Inc., at the Conference on Glass Problems, THE GLASS INDUSTRY in its review in the January issue inadvertently misquoted Dr. Shively in his remarks concerning the availability of selenium. The reference read, "the glass industry is getting at least 25% less selenium than in previous years." It should have been stated, "the glass industry is now receiving only about 25% of the selenium previously available to it."

• DESIGN
• ERECTION
• OPERATION

of Glass Plants

DOMESTIC AND FOREIGN

Complete Glass Plants and Equipment, Batch Systems, Glass Melting & Sodium-Silicate Furnaces, Batch Feeders, "Schmid" Mechanical Gob Feeders, "Liberty" Pneumatic Gob Feeders, Automatic Handling Equipment, Stackers, Lehrs, Machines, etc. for manufacture of containers, flat glass, pressed ware, and tubing. Furnace Repairs and Rebuilding. Process Engineers.

ARTHUR W. SCHMID COMPANY

ENGINEERS AND CONTRACTORS

INVESTMENT BUILDING, PITTSBURGH, PA.

Cable address: "Schmid" Pittsburgh
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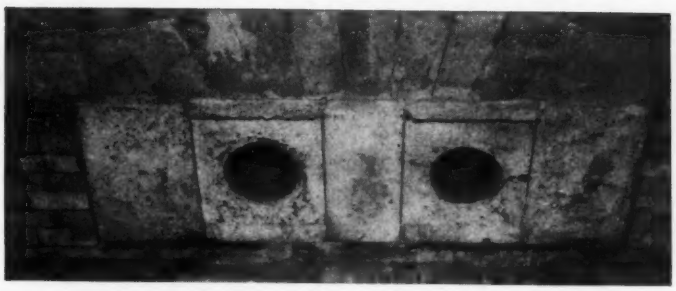
The trend is toward

MONOFRAX
FUSED CAST
refractories



This burner assembly — made of MONOFRAX H refractories — is one of six, located over the first three ports of an amber container tank.

ONE PLACE TO REDUCE STONES and cords is right here. Volatilized alkalies, batch dust, and silica drip, all tend to attack crown burner blocks. Any chemical reaction, and the refractory starts to spall off into the glass. Another reason for refractory-caused defects can be erosion due to flame impingement. If the burner holes become enlarged, the flame pattern may shift enough to be destructive to other adjacent refractories.

The ideal material for this and other vulnerable superstructure locations is MONOFRAX H fused cast refractory. Containing over 99% beta alumina, MONOFRAX H refractory is chemically inert, and resistant to high heat and direct flame impingement. With less than 0.5% interstitial glass content, this product does not tend to bleed, "honey-comb," and spall. Eutectic formations are avoided, and there is little that can contaminate the glass or cause glass defects.

WEST VIRGINIA — A melting end bottom of MONOFRAX MH refractories (12" thick, uninsulated) recently completed approximately 28 months' service in a shallow tank (24") producing clear glass tableware. This bottom was inspected, found in good condition, and left intact for at least another full campaign. The use of MONOFRAX refractories was extended to other parts of this tank during the general repair.

CARBORUNDUM
Trade Mark
Dept. L-23 Refractories Division
The Carborundum Company, Perth Amboy, N. J.

"CARBORUNDUM" AND "MONOFRAX" ARE REGISTERED TRADEMARKS OF THE CARBORUNDUM CO. — WORLD'S LARGEST MANUFACTURER OF SUPER REFRACTORIES.

NEW EYEGLASS LENS REPORTED TO HELP PARTIALLY BLIND

The first professional demonstration of a "clear image" lens, said to be powerful enough to give "adequate" eyesight to partially blind persons, was made recently by Dr. William Feinbloom, New York optometrist, before a meeting of the Brooklyn Optometric Society.

Although not offered as a "cure-all" or a panacea for persons of very limited vision, Dr. Feinbloom said that the new lens—the result of five years of intensive research and clinical tests—had had the following results: "Patients who never before viewed television clearly can now see the TV screen with maximum clarity. They can read newspapers, magazines, and books, while without the lens they have had to depend on the eyes of others. The new lens should mean a return to normal work and living to many of those now classified with the blind."

Dr. Feinbloom explained the news lens in this manner: "For the first time, the principle of aspherical surfaces is employed as an aid to the human eye. These surfaces are departures from the spherical surfaces found in ordinary spectacles or magnifying glasses. Thus, instead of being curved like a ball (spherical), the new lens is slightly flattened or parabolic (aspherical) toward the edges."

SAFETY TRAINING COURSE ANNOUNCED

The 1953 sessions of the National Safety Council's Safety Training Institute will open with a five-day course on the "Fundamentals of Industrial Safety," to be held February 16 through 20.

This basic course, designed to help men presently engaged in industrial accident prevention gain a better understanding of occupational safety principles and methods, will be offered six times during the year. Among the subjects included in classroom work are accident records, safety inspections, workmen's compensation, industrial health problems, machine guarding, electrical hazards, fire prevention, personal protective equipment, personal factors, and supervision.

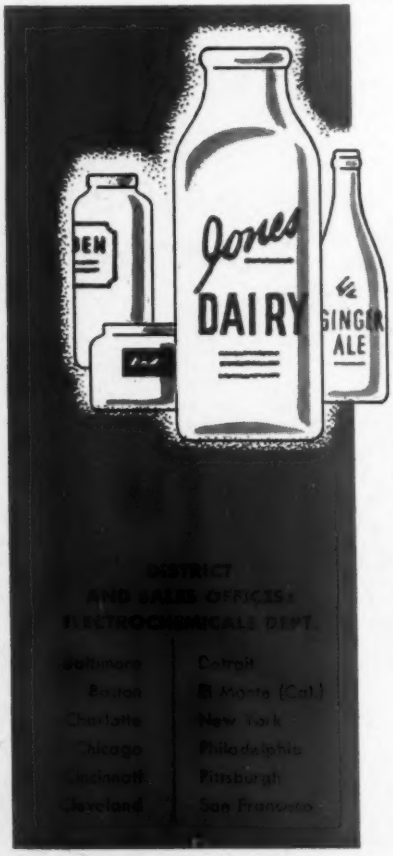
The next advanced course on "Safety Management Technique" will be given April 13-17. In addition to the February meeting, the basic course will be offered March 9-13, May 11-15, June 8-12, November 9-13, and December 7-11.

WICKWIRE SPENCER APPOINTMENT

Sam W. Densmore's appointment as Warehouse Manager for the Wickwire Spencer Steel Division of The Colorado Fuel and Iron Corporation has been announced by H. C. Allington, General Manager of Sales.

Mr. Densmore joined the then Wickwire Spencer Steel Company in 1928 and has served in various capacities in the company's New England mills. His most recent position was that of New England District Sales Manager.

The position of Warehouse Manager has been created to standardize warehouse procedures and operations within the Wickwire Division. It is a part of a continuing program to better serve our friends and customers.



It's Du Pont Glass Colors

FOR UNIFORMITY AND EASE OF APPLICATION

A COMPLETE LINE of glass colors for every decorating need is available from Du Pont. These durable colors are produced against a permanent standard under carefully controlled laboratory conditions . . . assuring maximum uniformity both of color and firing characteristics.

Easily applied in designs of all types, Du Pont colors assure maximum coverage over a wide firing range . . . reduce costs in glassware decoration. Their excellent resistance to chemicals and defacement means extra durability under every service condition—a feature that adds to the sales appeal of your product.

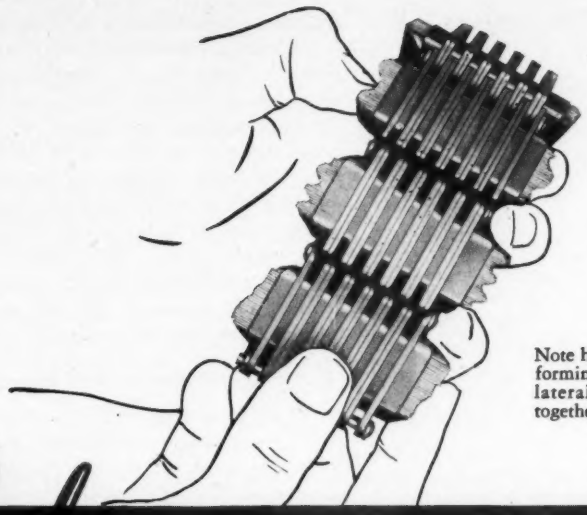
DU PONT TECHNICAL MEN stand ready to give you prompt assistance in your decorating problems. Drawing on their broad experience in the field, these men can help you increase efficiency . . . cut production costs. For more information about Du Pont glass colors and technical assistance, get in touch with your nearest Du Pont district office or write to E. I. du Pont de Nemours & Co. (Inc.), Electrochemicals Department, Wilmington 98, Delaware.

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

DU PONT GLASS COLORS



Note how slats in the self-tooth-forming chain are free to move laterally — either singly or together.

Only **the P.I.V. variable speed drive uses**

SELF-TOOTH-FORMING CHAIN

to give you positive, stepless speed changing

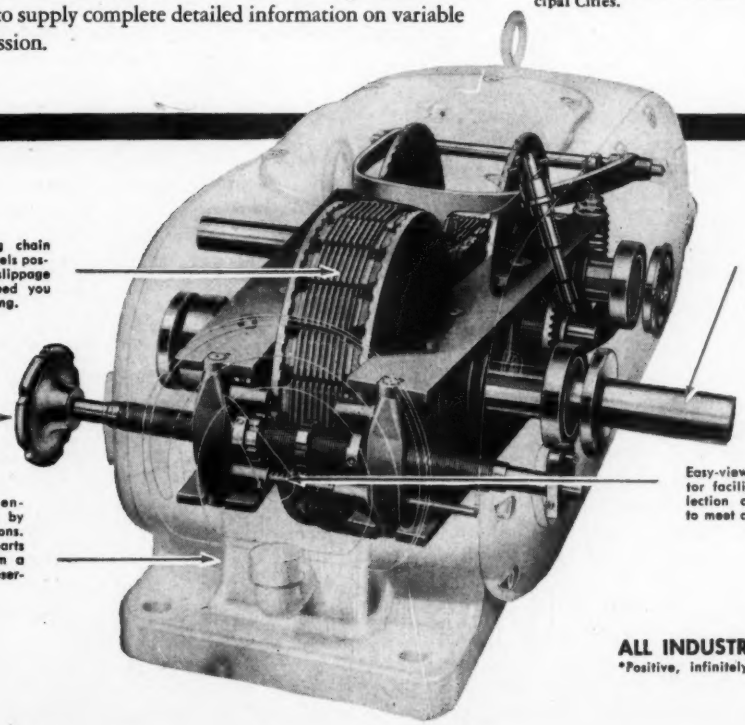
The operation of Link-Belt's P.I.V. Variable Speed Drive is not dependent upon friction for power transmission.

That's because only Link-Belt's P.I.V. has the self-tooth-forming chain that allows *positive,* stepless speed adjustment.

If you've been looking for exact speed changing that will deliver full rated horsepower to your machines, it will pay you to call your nearest Link-Belt branch office, as our representatives are equipped to supply complete detailed information on variable speed transmission.

LINK-BELT P.I.V. VARIABLE SPEED DRIVE

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices, Factory Branch Stores and Distributors in Principal Cities. 12,272



Self-tooth-forming chain grips toothed wheels positively without slippage — gives the speed you need at any setting.

You can get minute speed changes and maintain them accurately while operating under full load.

An infinite number of positive, stepless speed adjustments may be made with manual, electric, pneumatic or hydraulic controls.

Easy-view speed indicator facilitates speed selection and adjustments to meet all requirements.

All-metal, totally enclosed — unaffected by atmospheric conditions. All vital operating parts splash-lubricated from a common housing reservoir.

ALL INDUSTRY USES P.I.V.*

*Positive, infinitely variable

ELECTRICAL GLASS MELTING . . .

(*Continued from page* 69)

to 0.13% per day. As one quite important result of this study, the fact was established that, when the electrodes were cooled (air-cooled), no loss of weight could be demonstrated after 16 days of operation.

Carbon (graphite), the electrode material most used, colors the glass intensively. The cause of the carbon coloration is not clearly understood. Opinions differ, whether carbon alone colors glass or only in the presence of small quantities of sulfides in the batch, through the formation of strongly-coloring iron-sulfur compounds. These debatable questions have no great importance; it is not practical for the glassmaker to use completely sulfur-free raw materials. It was shown with carbon, as with iron, that extremely pure, dense, and homogeneous material is almost unattacked.[17, 18] Practice has proven that graphite electrodes may be used with success in glass melting tanks in which green bottle glass, three-quarters-white window glass, and similar qualities are produced. Graphite electrodes have been used since 1936 in the window-glass furnace of Electroverre Romont S.A., in Romont (Switzerland), as well as in several other plants using the same system; also in plants using the Souchon-Neuvesel procedure. While it is possible to use graphite electrodes for the glasses just mentioned and for amber, they have not yet been successful in melting flint (crystal) hollowware.

No electrode material exists that will not be attacked by the glass melt and that can be used in practice. The endeavors of the inventor and builder must be directed, accordingly, to holding the quantity of coloring oxide taken up by the glass as low as possible, and also toward providing for such thorough homogenizing as will hinder cord formation.

The amount of oxide dissolved by the glass from the electrodes depends on the following factors:

(1) *Temperature.* Since a chemical reaction is concerned, the attack increases rapidly with mounting temperature. Numerous builders have on this account resorted to cooling the electrodes as a remedy.

(2) *Area of contact surface.* The amount of dissolved oxide is obviously proportional to the surface of electrode immersed.

(3) *Current density* where the electric current passes from the electrode into the glass bath. Since electrolytic action concentrates, the attack is less when current density is lower.

It follows that small electrodes should be used in order to have small contact surfaces. At the same time, a low current density should be impressed upon them. Also, the temperature at the electrodes should be as low as possible. These are, however, opposing requirements, mutually excluding each other. Small electrode surface compels high current density and, since according to Joule's Law the heat developed is proportional to the square of the current strength, it is clear that in the neighborhood of small electrodes a greater evolution of heat and with that a higher temperature will prevail.

Time also plays a part. Shorter time of contact between electrode and glass means less attack and less solution of oxide.

It is true, therefore, that in the most limited time, a correspondingly greater mass of glass will have taken up coloring oxide. This is quite desirable. In order to prevent streaks from forming, the most thorough mixing of the glass melt is to be sought, which is understandably more easily attained, if the coloring oxide is distributed in a large quantity of glass. As pointed out earlier, the glass flows in the tank, oriented in the direction of temperature drop. It behaves like an ordinary convection current. High temperature near an electrode immersed in the glass bath, therefore, is in favor of homogenizing and mixing of the glass. The convection current starts at the hot spot near the electrode, raises the speed of flow, and thus decreases the time that the glass remains in contact with the electrode surface.

Influence of Electrode Arrangement

The type and manner of arrangement of round, rod-form electrodes in an electrical melting tank have a considerable influence on the glass currents automatically generated. Round about the electrodes, the glass is highly heated. Fig. 5 shows that, viewed horizontally, the hot glass underneath an electrode is not free to rise so that the convection currents cannot form, fully and unhindered. On the contrary, when round, horizontal electrodes are set perpendicular to the long axis of the tank, they cause convection currents which on one side hasten, and on the other retard the forward streaming of the glass along the tank. Peyches has remarked that thereby is set up a thermal dam ("barrage thermique") similar in effect to a floater or a bridgewall. This is especially the result when the electrodes are set near the glass surface and project far enough to span the entire width of the tank.

Much more favorable is the situation when round electrodes rise vertically through the tank bottom. Here, as shown in Fig. 6, the hot glass can rise free and unhindered and create a "spring" at the surface. The convection currents are thereby improved and increased, better mixing and homogenizing takes place, and good decolorizing may be expected. This vertical placement accelerates the upward movement of the intensely heated glass near the electrodes and thereby limits also the danger of overheating the glass adjacent to the electrodes. The improved mixing of the glass bath works also toward lessening temperature differences and therewith also the differences in conductivity of the current-carrying layers between the electrodes.

(*To Be Continued*)

SAFETY FILMS

The foreman's key position in the plant safety program is the theme of two safety films recently released by the National Safety Council.

"Pick Your Safety Target," an all-color cartoon film based on actual accident-reduction plans within industry, features a foreman beset with an accident-ridden department. The film sets forth a three-step plan for detecting accident causes and taking corrective action.

The second film, "A Gray Day for O'Grady," employs a series of comedy situations to dramatize the high cost of accidents.

Information concerning these films may be obtained by writing to the National Safety Council, 425 North Michigan Avenue, Chicago 11, Illinois.

CHEMICAL ENGINEERING FACULTY DIRECTORY

A directory of chemical engineering faculties in the nation's colleges, giving courses in chemical engineering, has been announced by the American Institute of Chemical Engineers.

This listing, which is available from the organization at 120 East 41st Street, New York 17, N. Y., is the work of their chemical engineering education project committee under the supervision of Kenneth A. Kobe, Professor of Chemical Engineering at the University of Texas. The listing details all professors, assistant professors, and instructors, now staffing the nation's chemical engineering departments; lists the official positions of all teaching personnel, information on degrees granted at each college, type of graduate work being done, accrediting information, and the number of unfilled staff positions.

BAUSCH & LOMB PROMOTIONS

The promotion of John D. Harby to Superintendent of Instrument Engineering and J. Donald Dutcher to Superintendent of Instrument Manufacturing has been announced by Bausch & Lomb Optical Company.

A graduate of the U. S. Naval Academy, where he earned a mechanical engineering degree, Mr. Harby joined the optical firm in 1939, and during World War II supervised the assembly of medium base rangefinders. Since 1949, he has been in charge of instrument engineering and inspection. In his new post he will supervise all instrument engineering functions, including factory engineering, process determination, cost and quality control, tool specifications, and tool design.

Mr. Dutcher, who studied business administration at the University of Rochester, joined Bausch & Lomb in 1936, and was promoted to foreman of the Instrument Assembly Department the following year. During World War II, he supervised assembly of small rangefinders before becoming superintendent of assembly operations. In 1946, he was one of the three Bausch & Lomb men awarded a Certificate of Exceptional Service by the Bureau of Navy Ordnance for producing a pressure-proof submarine binocular. Mr. Dutcher will supervise manufacturing operations in the firm's precision optics, instrument parts, assembly, special order, foundry, and optical machinery divisions.

GENERAL REFRACTORIES PURCHASING STAFF CHANGES

Richard J. Skillman has been named Purchasing Agent of General Refractories Company, succeeding John A. Ross, who has been appointed Director of Purchases.

Mr. Ross, who has been Purchasing Agent since 1919, joined the Wynn Fire Brick Company, which company was subsequently purchased by General Refractories Company.

Mr. Skillman, who has been Assistant Purchasing Agent since 1946, joined the firm in 1946. He is a graduate of Princeton University, and during the war served as a Lieutenant in the United States Naval Reserve.

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INVENTIONS AND INVENTORS . . .

(*Continued from page* 81)

beads of uniform diameter from molten glass in a single operation is described. The details of operation are shown in Fig. 11. Molten glass 34 is fed from a refractory container 30 through the orifice 31. The flow of glass is regulated by means of the vertically adjustable refractory valve 38. A stalagmometer container 1 receives the molten glass and rotation of the container causes molten glass beads to issue from the many capillaries located at the bottom and outside edge of container 1. Glass issuing from the capillaries will be thrown from the tips thereof in the form of small beads of nearly uniform size. Rotation of the container increases the force effective in each bead as formed at the outer end of a capillary and thus decreases the bead size and increases the rate of production of beads per capillary. Substantial uniformity of temperature of glass entering the capillaries and at their tips assures formation and throwing off of the beads rather than fibers or fiber with beads at their leading ends. The beads after forming are conducted down the cone 51 into a spiral through 52 which conducts them eventually to a container 55.

The patent contains two claims and the references cited were: Re. 12,568, Cowing, Nov. 27, 1906; 2,061,696, DeBats, Nov. 24, 1936; 2,192,944, Thomas, Mar. 12, 1940; 2,217,235, Rieser, Oct. 8, 1940; 2,431,205, Slayter, Nov. 18, 1947; and 497,586, Great Britain, Dec. 19, 1933.

Cathode-ray Tube for Colored Television. Patent No. 2,614,231. Filed April 4, 1951. Issued October 14, 1952. One sheet of drawings. Assigned to Chromatic Television Laboratories Inc. by E. O. Lawrence.

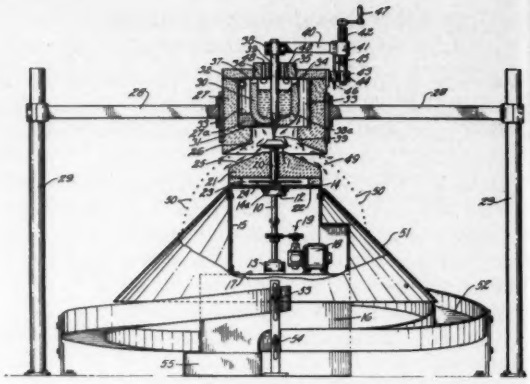

Fig. 11.

This invention relates to cathode-ray tubes for displaying polychrome television images. The patent is a continuation of co-pending application Serial No. 150,732 filed March 20, 1950. Provision is made whereby a modulatable signal-controlled cathode-ray beam may be directed through a cathode-ray color image-producing tube to impact at one end of the tube a phosphor or luminescent compound to recreate the image in one color. The color is one to which the eye is sensitive. The actual selection of phosphor or other luminescent material is somewhat a matter of choice.

The patent contains 18 claims and 13 references were cited.

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CURRENT STATISTICS . . .

(*Continued from page* 84)

Manufacturers' sales of machine-made table, kitchen, and household glassware during December 1952 dropped 10.1 per cent to reach 3,295,469 dozens. During December 1951, sales were 2,589,760 dozens. At the end of the 12-month period ending December 1952, sales totaled 41,136,908 dozens, which is 5.1 per cent more than the 39,139,208 dozens sold during the corresponding 1951 period.

On page 85 of this issue, there appears a summary of the dollar value of production, imports for consumption, and domestic exports for the entire U. S. glass and glassware industry, including flat glass, glass containers, pressed and blown glassware of every description. It will be noted that imports of handmade glass tumblers, table, stem, and ornamental ware for 1951 totaled $4,632,880, or 21.4 per cent of the total of imports of all kinds of glass, but the exports of that same ware were only $430,043, which is 2/3 of 1 per cent of the total exports.

"GLASS SKIN" USED FOR BOAT REPAIR AND MAINTENANCE

Fiberglas-reinforced plastic, already used in the manufacture of many types of boats, is now providing a new approach to boat repair and maintenance A newly-introduced coating of resin and Fiberglas cloth, known as Kristal Kraft, is applied simply and economically to any part of a wooden boat. The application of this "glass skin" reportedly eliminates seams, caulking, and puttying of old or new craft.

Because the coating contains inorganic Fiberglas strands, it provides great strength, cannot be penetrated by worms or harmed by barnacles, and is not weakened by chemical or corrosive matter found in fresh or salt water. The smooth bottom and the low water pickup resulting from an application of Kristal Kraft covering eliminates waterlogging which, in turn, means a lighter boat and greater speed.

PENNSALT ANNOUNCES STAFF TRANSFERS

Philip C. Staples has been appointed Chicago District Sales Manager of the Industrial Chemicals Department of the Pennsylvania Salt Manufacturing Company. He replaces John C. Hampson, who returns to the Philadelphia office as a Product Supervisor in the same department.

Mr. Staples joined Pennsalt in 1937. He has served in the company's Technical Service Department, Sales Development Department, Metal Processing Department, Industrial Chemicals Department, and most recently was Manager of the company's Washington office.

Mr. Hampson joined the firm in 1936 as salesman in the Food Industries Department. He subsequently served in the Purchasing Department as an expediter and then returned to sales in Metal Processing and Industrial Chemicals. He was Chicago District Sales Manager for two years before his recent appointment.

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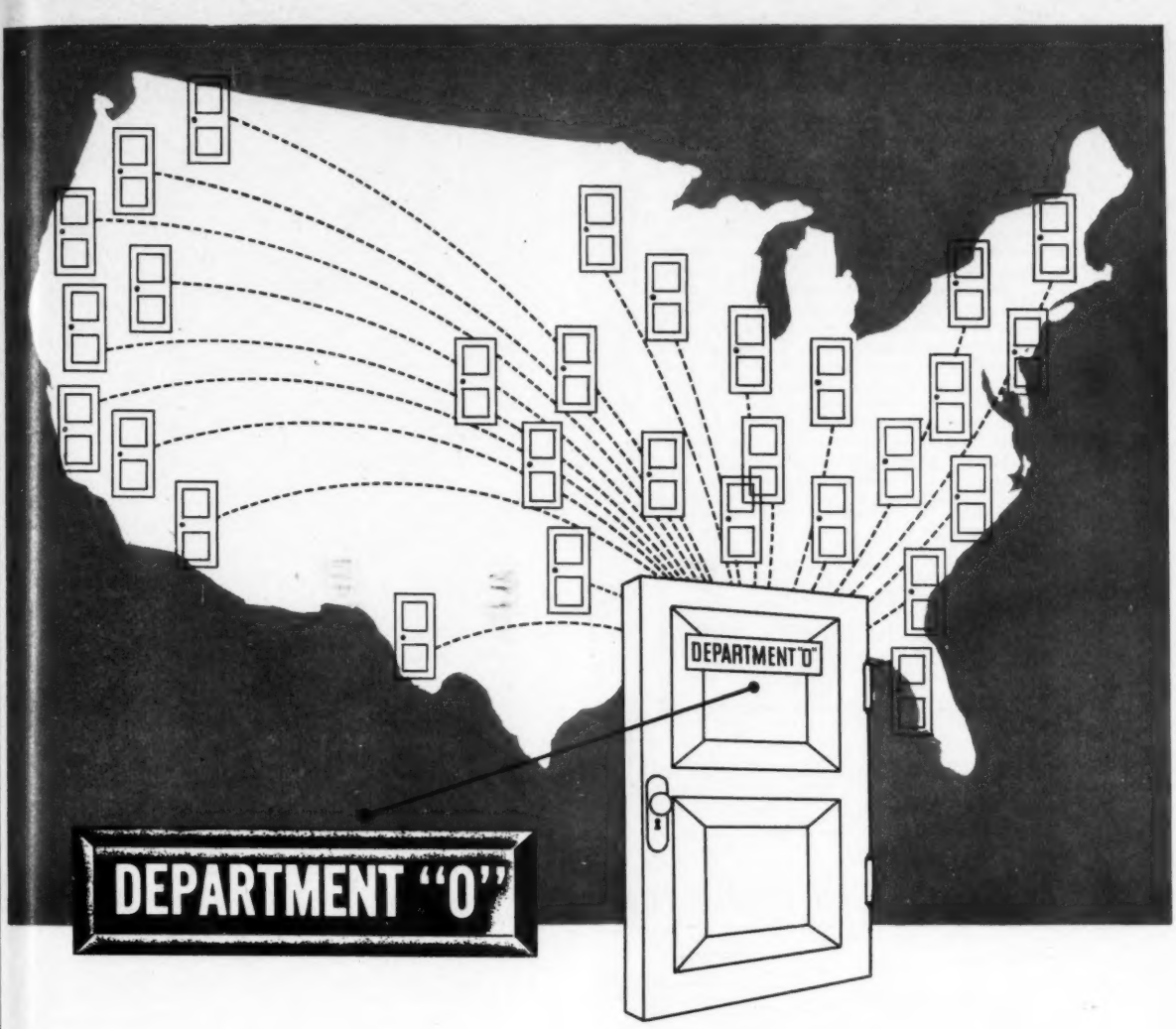

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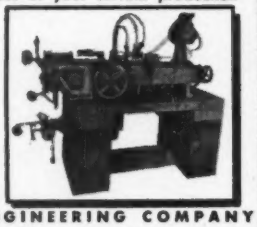

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ALEXANDER KERR INTRODUCES "RIPPOLITE"

Alexander H. Kerr & Co., Inc., Panel and Plastic Division, has introduced "Rippolite" translucent, structural panels. This panel is the first of a series of new products being manufactured by the Kerr Panel Division.

A molded glass fiber-reinforced plastic, Rippolite is manufactured into light-weight corrugated, flat, and molded panels allowing light transmission without glare and minimizing heat from sunlight. Uniform color intensity gives uniform diffusion of light making it ideal for skylighting or any decorative lighting installation.

The Rippolite panels are available in a variety of colors, in standard lengths up to twelve feet and widths up to four feet.

GLASS FIBERS APPOINTS GENERAL MANAGER

Thomas A. Collins, Executive Vice President of Glass Fibers, Inc., has been appointed General Manager of the company, according to a recent announcement by R. H. Barnard, President. In his new capacity, Mr. Collins will coordinate production, sales advertising, and public relations activities.

Before coming with Glass Fibers, Inc., Mr. Collins served in various managerial capacities with Owens-Illinois Glass Company for 26 years. Most recently he was General Manager of its Kaylo Division. Mr. Collins will headquarter at the company's home office in Toledo.

NATIONAL SUN GLASS WEEK

National Sun Glass Week for 1953 will be the week of May 25 to 30, according to an announcement by Raymond J. Walter, Secretary of the Sun Glass Institute.

Industry-wide promotion, featuring the combined efforts of the leading sunglass manufacturers in this country, will emphasize the importance of sunglasses as a fashion and beauty accessory, and the protection sunglasses afford against dangerous effects of sun glare. According to Mr. Walter, the 1953 sunglasses will be the most fashionable ever produced by the manufacturers.

ALSYNITE USED IN GREENHOUSE CONSTRUCTION

A new building panel, which eliminates many greenhouse hazards, has been proved successful in an extensive four-year test conducted by the Santa Barbara, California, Botanic Gardens.

Alsynite is a translucent plastic sheeting made by combining resins and glass fibers, under heat and pressure, into sheets of great strength, attractiveness and permanence. It was subjected to rigid inspection during the past four years at Santa Barbara to determine its value in commercial and home greenhouses.

A complete report of the test by C. H. Muller, research associate, indicates that Alsynite permits transmission of a good balance of light from infrared through ultraviolet. Unshaded Alsynite is equivalent to lightly painted glass. Its impregnation with fiber glass results in a diffusion of transmitted light, reducing shadows and giving very even illumination, according to Mr. Muller's test report.

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